ILLUMINATING ENGINEERING

MARCH 1953

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Control and Measure of Directional Flux at the Task
I.E.S. Officers and Committee Personnel
New Approach to Underpass Lighting
Characteristics of Alzak Aluminum
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THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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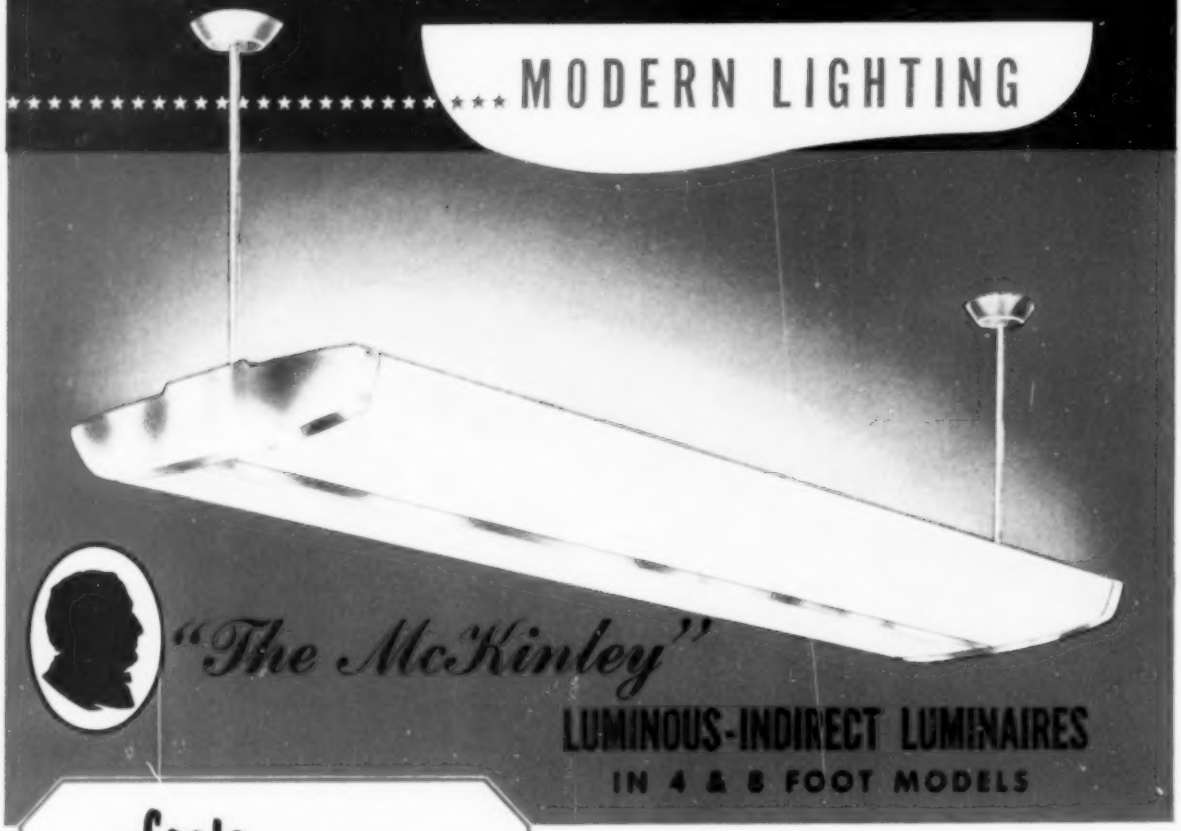

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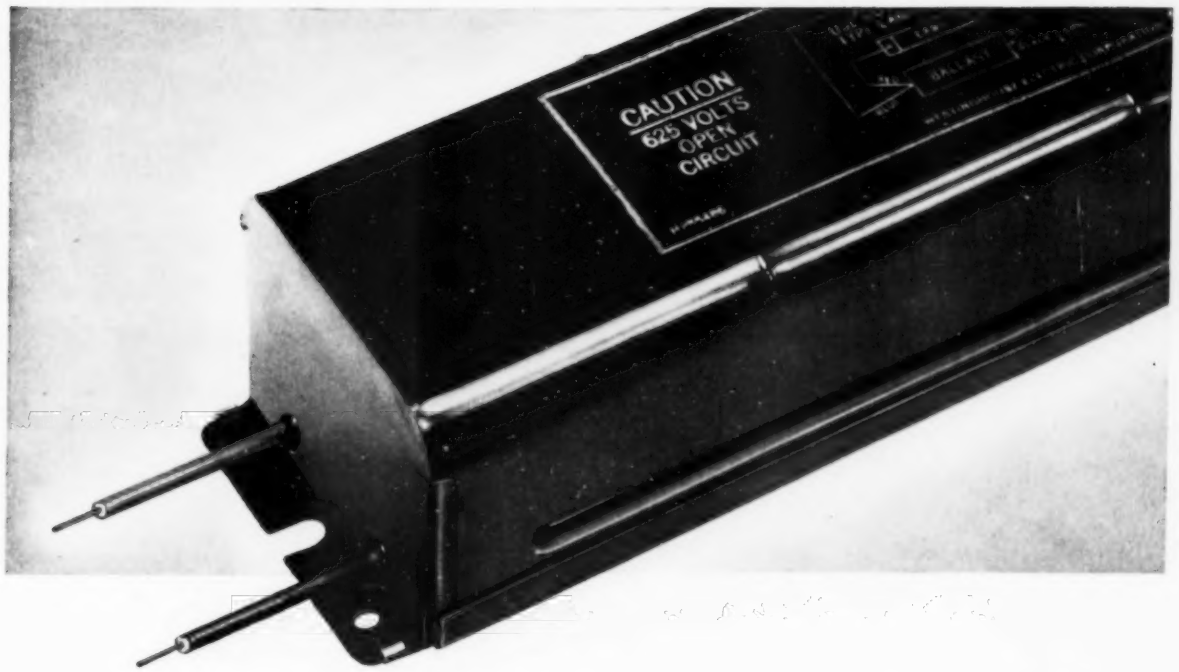

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Unretouched photograph of the Quincy School, Dedham, Mass. Electrical Contractor: Robert L. Tibbetts, Dedham. Area: 804.5 square feet. Fixture Mounting Height: 10'-0". Fixture spacing: 10'-0". Fixtures: 9- No. 6628 pendant mounted, with 2-T1296 Standard Warm White Slimline lamps each. Watts per fixture: 177. Watts per square foot: 1.98. Room Finish: Cream yellow upper walls; olive green paint on chalkboards, using yellow chalk; dark varnished woodwork; scrubbed pine floors 9% approx. 20% reflection factor. Readings at desk level: (20"-21" from floor), Average, 51.7 Footcandles initially. Vertical Readings on chalkboards: 28 Footcandles average.

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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Vol. XLVIII
No. 3

A New Approach to Underpass Lighting — H. G. Hrivnatz — 121

Control and Measure of Directional Flux at the Task — G. P. Wakefield — 124

Characteristics of Alzak Aluminum as Used in the Lighting Industry — Herbert Lyons and William Weibel — 135

Supermarket Lighting for Atmosphere — 140

The Zonal Method of Computing Coefficients of Utilization and Illumination on Room Surfaces — J. R. Jones and J. J. Neidhart — 141

I.E.S. Lighting Data Sheet — Series XVIII
Lighting a Large Office (13-73) — 169

Questions and Answers on Light Sources — 171

Also: Multiple Lighting System in an Optical Dispensary, 123; Flexible Lighting System for a Country Club Dining Room, 134; Underpass Lighting with Fluorescent, 139.

TELECAST — Lighting News of Current Interest — 6A
Here and There with I.E.S. Members, 7A; Know Your Society — Meet Your Regional V-P, 8A; Lighting Calendar, 9A; About People, 13A; Obituaries, 15A; It Seems to Me, 15A; New Members, 15A.

I.E.S. National and Local Officers, 1952-1953 — 18A

I.E.S. Committee Personnel, 1952-1953 — 22A

Local Representatives, 1952-1953 — 32A

Index to Advertisers — 37A

Sustaining Members — Refer to February 1953 issue of ILLUMINATING ENGINEERING.

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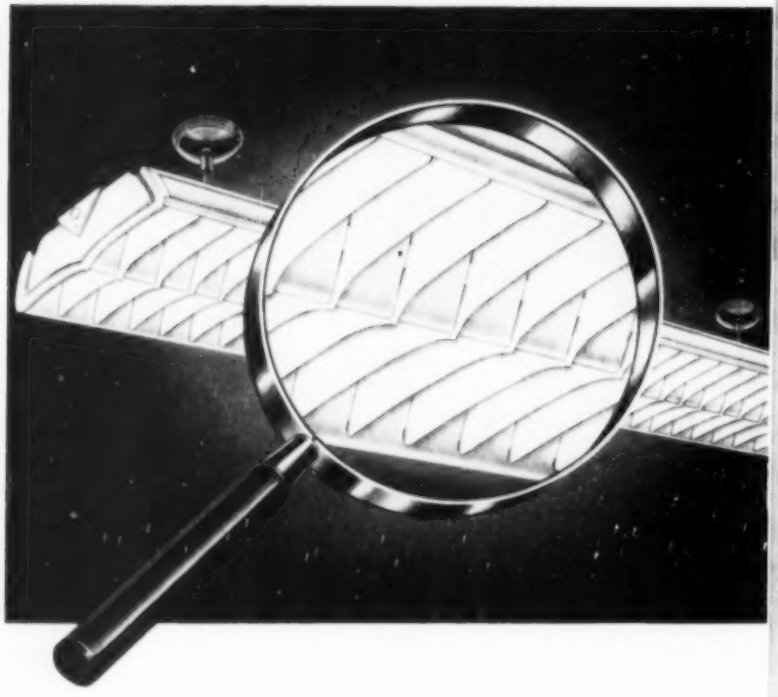

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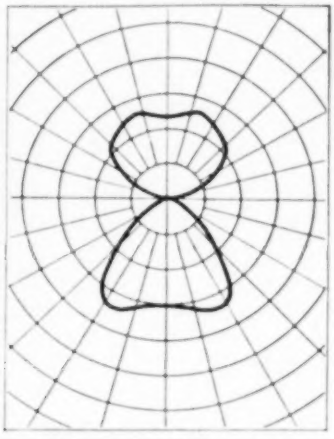

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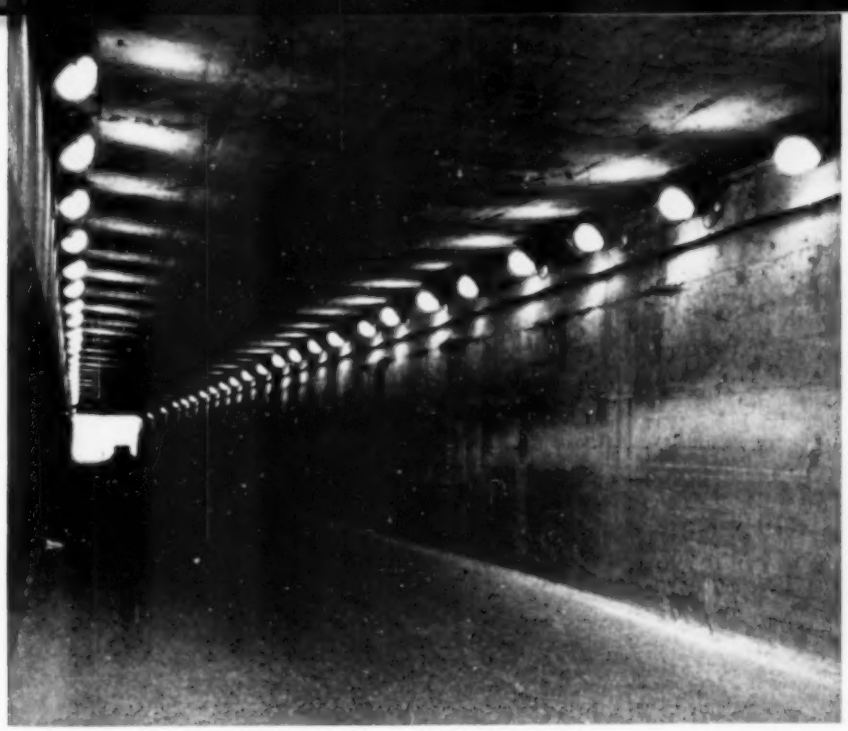


A New Approach to Underpass Lighting

By H. G. HRIVNATZ

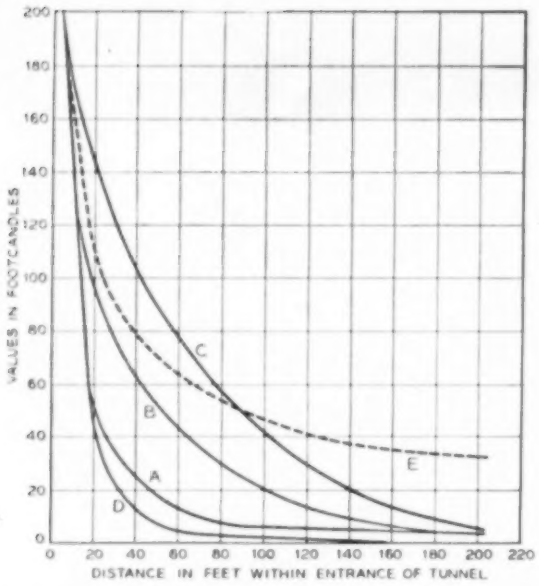
UP TO A FEW years ago, very little study had been given to underpass lighting. This lighting problem has always been considered as similar to that of tunnel lighting. Many engineers have found that this is not always so, however, when considering an installation for a short tunnel or underpass, which may be only 300 to 800 feet in length.

These short structures present a greater traffic hazard than longer ones because the speed of traffic carries the driver through the structure before his eyes have had an opportunity to adapt themselves to the varying values of illumination plus the inherent glare factor which such structures present at the exit end. Under the conditions prevailing with most underpasses, the driver is blinded by the brightness of road reflections or by sky-brightness seen through the exit end around a foreground of dark interior walls and ceiling.

The North Main Street underpass of Houston, Texas, which is about one mile from the center of the city, has been a traffic problem for many years. The underpass consists of a double lane for outbound traffic and a double lane for inbound traffic. Each section is 21 feet wide. This particular underpass is 490 feet long, running in a north and south direction. The approaches as well as the interior walls and ceiling are painted white. With new lighting just completed, the interior will be repainted white and the approaches will be painted a dark maroon color.

It takes approximately 10 to 17 seconds to drive from the entrance to the exit of this short underpass when traveling 20 to 30 miles per hour. In terms of illumination values, on a bright sunny day you may have found, before the new lighting system, 6000 to 8000 footcandles on the white-washed approaches and a value of only one footcandle or less at the center of the underpass. As the motorist proceeds, he encounters a rapid increase again in going from the center of the underpass to the exit where thousands of footcandles are again encountered, setting up the undesirable condition of trying to see details or objects within the underpass with less than one footcandle of light, while the eyes are still adapted for thousands of footcandles. At the same time, the driver must try to see against an extremely bright background at the exit end, which is always in the line of vision.

AUTHOR: Houston Lighting and Power Co., Houston, Texas.



A—Borderline Seeing (observers at concentrated attention)

B—Minimum for Safe Seeing (factor of safety, approximately 2)

C—Recommended for Safe Seeing (factor of safety, approximately 5)

D—Daylight Penetration (entrance 42 ft. wide, 14 ft. high)

E—Actual readings made in North Main Underpass, Houston, after four months service.

Figure 2. Daytime lighting requirements for tunnel entrances, driving speed of 35 miles per hour; and readings made in North Main Underpass.

A number of years ago the lighting system was improved by the installation of 19 heavy-duty floodlights placed on the top portion of the right-hand wall of each traffic section. The floodlights were designed to use the G-30, 250-watt projector lamps and were spaced somewhat closer at the entrance (approximately 10 feet on centers), spreading out to a greater distance (approximately 30 feet) throughout the rest of the underpass. The average calculated value of illumination for this installation was one footcandle. The G-30 lamp in a polished aluminum reflector in the floodlights gave very poor distribution of light. Further, the floods were adjusted to project the light in the same direction as the flow of traffic and downward onto a dark road bed. All of this resulted in a dark passageway with no appreciable amount of light projected or reflected onto the walls and ceiling areas.

In later years the floods were readjusted to project light against the flow of traffic, thinking that a brightness pattern could be created against which drivers could see by silhouette. This scheme was not successful. The floodlights were then turned to project light at right angles to the flow of traffic, which would illuminate the opposite wall directly, instead of the road bed. The underpass had been whitewashed and the resultant effect was much better than with any of the previous methods. This system of lighting was fine for night-time operation when the driver's eyes were dark-adapted and he had the aid of good car headlamps. However, the problem of tunnel or underpass lighting is to create a safe daytime as well as night-time environment for all drivers. The 1947 American Standard Practice for Street and Highway Lighting was consulted for a solution to this problem. It was surprising to note how little information was available on this subject. In the 1947 Practice* it amounted to a graphic representation of daylight requirements, along with two short paragraphs of very general remarks. No specific recommendations were made.

The design covering the relighting of the North Main underpass was started some years ago and since that time many different types of systems have been studied. Some involved fluorescent, slimline, incandescent and 250-watt mercury vapor light sources, with many varying cost estimates. Almost all of the systems studied would employ specially designed lighting units which were felt to be required for the particular construction and the dampness within this underpass. A great deal of effort was then directed to studying standard and proven equipment for this lighting job.

Limiting factors affecting the type and location of the lighting units are the low ceiling height of 14 feet in the underpass, and the ever-present dampness on walls and ceiling. This meant that the ultimate unit to be used had to be small in physical dimensions, able to deliver an abundance of light, and had to be located in the corner of the underpass between ceiling and wall. A readily available mercury-vapor street lighting luminaire of relatively small dimensions (12-inch diameter), mounted with its axis parallel to that of the underpass, seemed to fill the essential requirements.

Calculations, based on using the 20,000-lumen E-H1 mercury-vapor lamp, indicated that approximately 100 footcandles would be obtained if units were staggered on about 4-foot centers at the entrance. The maximum distance of 30 feet on which these luminaires could be spaced apart toward the exit end, and still maintain a fairly even level of illumination, was determined by a trial installation. A 30-foot spacing gives approximately 10 footcandles of even light.

Final design called for a total of 108 luminaires placed in the corners of each section, divided into

*See August 1952 issue of ILLUMINATING ENGINEERING for revised Street Lighting Practice.—ED.

four rows of lights beginning with 4-foot spacing, then 6-foot, 10-foot, 20-foot, and the last section a spacing of 30 feet. All fixtures burn for daytime operation; only 36 burn for night-time operation. The night-time luminaires are on circuits which energize units that are staggered on 30-foot centers throughout both sections of the underpass. The photograph shows the view that a motorist sees as he approaches the underpass from the top of the approach. The 10-footcandle level inside the underpass is bright in contrast to the approaches. These will be relighted to one footcandle with mercury-vapor street lighting units in the near future.

The footcandle chart shown is from the 1947 American Standard of Street and Highway Lighting. Superimposed on this are the actual footcandle readings taken at the north entrance of the Houston underpass on an overcast day — October 15, 1952. These footcandle readings represent "in service" values as they were taken approximately four months after the completion of the project. Note that the curve falls fairly high on the chart. If it can be assumed that the basic hypothetical curve is fairly accurate, then the plotted curve indicates that the new tunnel lighting is adequate for safe seeing. Due to the shortness of the tunnel and the glare from the exit end, it was decided to carry a higher level of footcandles further into the tunnel. This proved very successful in overcoming these two detriments to good visibility.

A study of the lighting installations of other tunnels, such as Holland, Lincoln Brooklyn-Battery, Washburn, etc., did not give any outstanding impression of having solved the problem of eye adaptation for a driver going from thousands of footcandles outside to the extremely low levels of 5 to 25 footcandles that were found inside these tunnels. Correspondence with Mr. Finke of Seattle, Washington, about the relighting of the Lake Way Tunnels there proved to be of great value in the relighting of the North Main Underpass. This project* also used the standard mercury vapor street lighting luminaire, mounted in the normal position as for street lighting. The Seattle engineers were able to get 47 footcandles at the entrance section, which value was then tapered off to 5 footcandles toward the exit end. None of the other tunnels studied used standard street lighting equipment.

It is believed that the method of lighting the North Main Underpass is quite practical and economical and might well be given further consideration in the relighting of other underpasses and tunnels.

*See "Mercury Vapor for Tunnel Lighting," by Clement A. Felzer, August 1952 issue of ILLUMINATING ENGINEERING, p. 422.—ED.

Multiple Lighting System In an Optical Dispensary

A combination of direct and indirect lighting is used in the Spratt Optical Company, Los Angeles, Calif. The square flush-mounted units are louvered, containing 300-watt lamps. The three concentric ring luminaires use 300-watt silvered bowl lamps and illuminate the three customer booths at the left. Cone type units with 150-watt reflector spot lamps highlight merchandise in the front display cases.

The customer waiting area is illuminated by reflected light from the ceiling above the beams, each beam having a fluorescent lamp recessed, trough-like, in its upper surface. Illumination level in this area is 30 footcandles. The ceiling is generally white acoustical tile, 8′ 6″ in height. Above the beamed area ceiling height is 10′ 6″, painted a light blue color. Walls are walnut contrasted with brown trim. ***Photograph and data from Department of Water and Power, Los Angeles, Calif.***

Control and Measure of Directional Flux at the Task

By G. P. WAKEFIELD

THE DIRECTION in which light is reflected from a plane surface in relation to the position of the eye is an important factor in the study of reflected glare or veiling glare, as it is commonly called. Reflected glare attributable to this factor of direction is identified as "dimage" throughout this paper for the sake of brevity. Dimage, then, is the diffused image of a light source that dims visibility of the seeing task. Dimage is not to be confused with distraction glare, a nearby image that tends to lead the eye from the task.

Dimage is not easily or usually detected by the average individual, nor is its presence often given important consideration in normal lighting practice. This casual treatment of dimage bespeaks its subtleness.

Test Method

To study dimage, one must first see it. To see dimage, one must eliminate it, in part, in a comparative device which will provide an operational base for the eye. This base could well be called the minimum dimage area, or maximum visibility area if visibility were the prime subject. Adjoining this minimum dimage area, a maximum dimage area should be arranged at close hand for visual gauging. The level of illumination and the character of the task would, of course, be the same in both areas, so the only variable would be the direction of the flux reflected from the task.

A schematic diagram best illustrates the suggested arrangement. See sketch Fig. 1. An angle of 45° from the task plane to the source and eye was used as a practical match of existing occurrence. Light sources were located directly opposite the eye and at 90° to the normal viewing axis. In order to separate the two areas of minimum and maximum dimage, a right angle shield 6 inches high by 6 inches long in each plane was aligned with the visual axis of the eye. The baffle or shield was finished in dull black.

After visual verification of this technique, a preliminary camera study was completed which indicated that photographic records could be used to convey the comparative vision of dimage in its extremes.

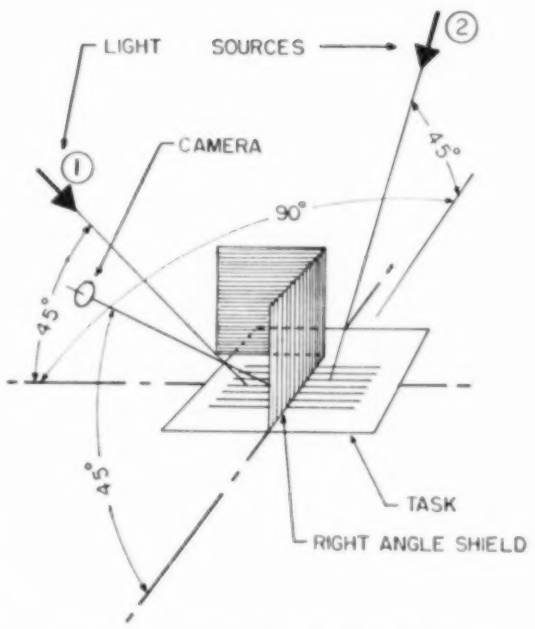


Figure 1. Schematic drawing of right angle shield technique.

Test Results

The first set of pictures, Figs. 2, 3, 4 and 5, were made using a 150-watt flood type projector lamp with 30 footcandles on the samples. The average source brightness was on the order of 75,000 footlamberts when viewed from the task. These pictures present magnified examples of dimage. Note the cylindrical indicators at left and right. The sharp shadow quickly indicates a small area source. Direction is obvious. Fig. 2 has the minimum dimage on the left and the maximum dimage on the right. This arrangement is typical of all the photos. Note the visibility of the near set of pencil lines on the left, while the same lines disappear at the right. The back lines are inked and seem to possess a better visibility characteristic than the pencil lines. This sample was of drafting paper.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHOR: The F. W. Wakefield Brass Co., Vermilion, Ohio.

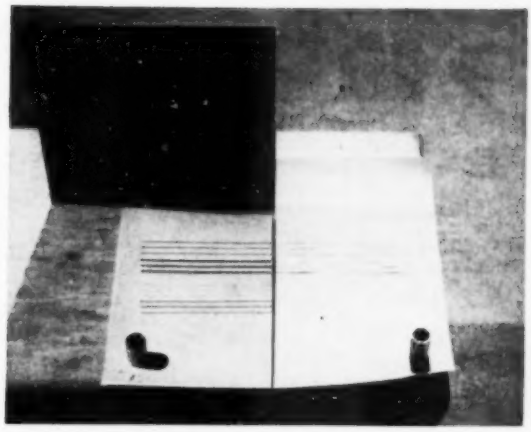


Figure 2. Drafting paper with pencil and inked lines under high brightness sources.

Figure 3. A glossy sample under high brightness sources.

Figure 4. Office copy paper under high brightness sources.

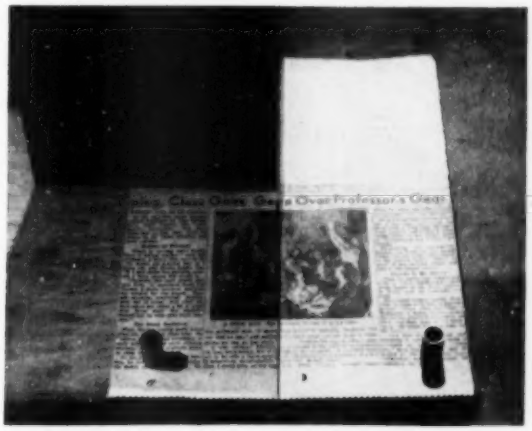


Figure 5. Newspaper under high brightness sources.

Fig. 3 shows a paper with which we are familiar. This is an excellent example of dimage and its effect on visibility.

Fig. 4 represents typing on regular office copy paper. Fig. 5 is of common newspaper of a dull finish but demonstrating considerable dimage.

All of these pictures illustrate the visual effect of direction of flux and dimage. Now then, let us use a light source more typical of standard practice and see what develops.

Fig. 6 shows the same drafting paper illuminated with 40-watt T-12 fluorescent lamps. Note the diffuse character of the light as shown by the shadow indicator right and left. Fig. 7 is drafting cloth with foreground pencil lines and background ink lines. Fig. 8 is the I. E. sheet again. Fig. 9 is regular office bond, while Fig. 10 is office copy

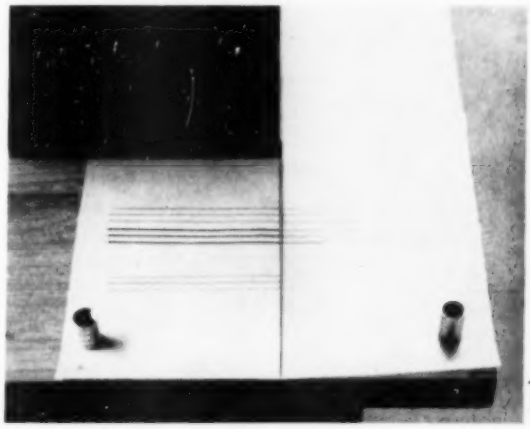


Figure 6. Drafting paper under medium brightness sources.

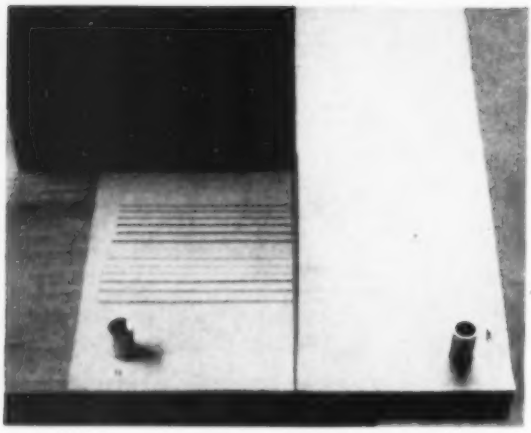


Figure 7. Drafting cloth under medium brightness sources.

Figure 8. A glossy sample under medium brightness sources.

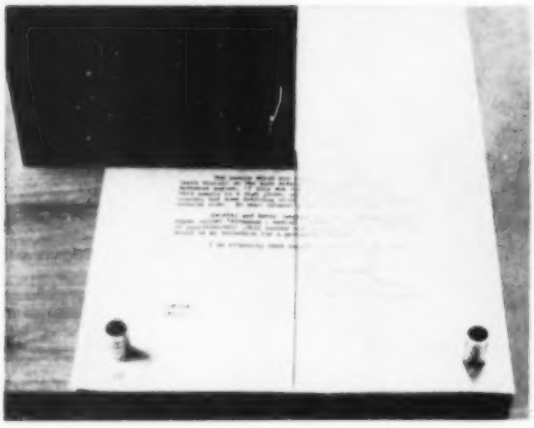


Figure 9. Office bond under medium brightness sources.

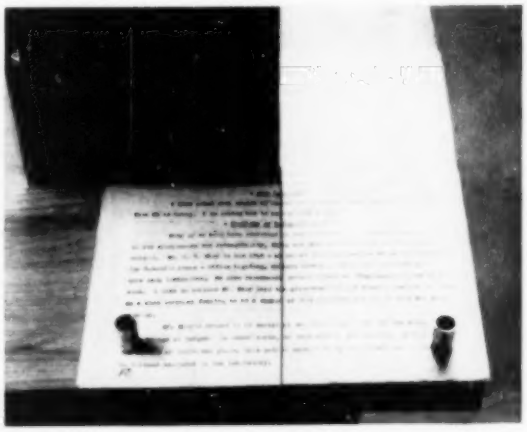


Figure 10. Office copy paper under medium brightness sources.

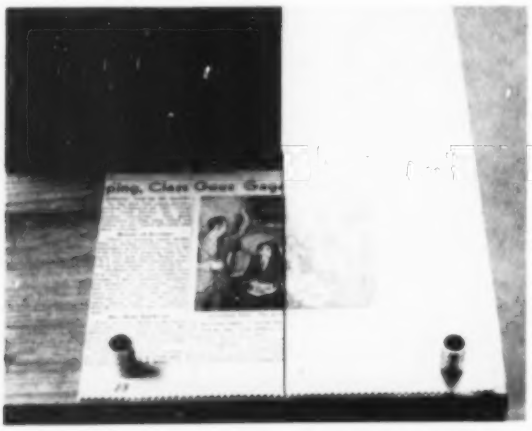


Figure 11. Newspaper under medium brightness sources.

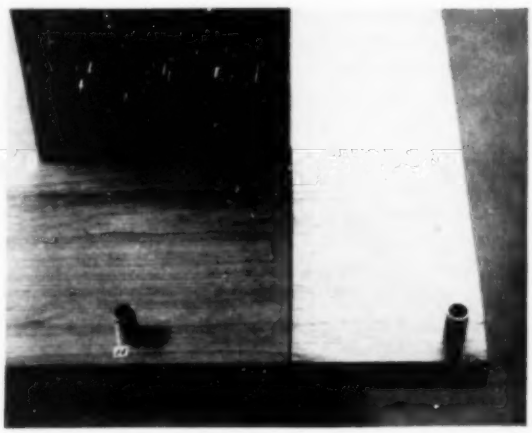


Figure 12. Varnished oak under medium brightness sources.

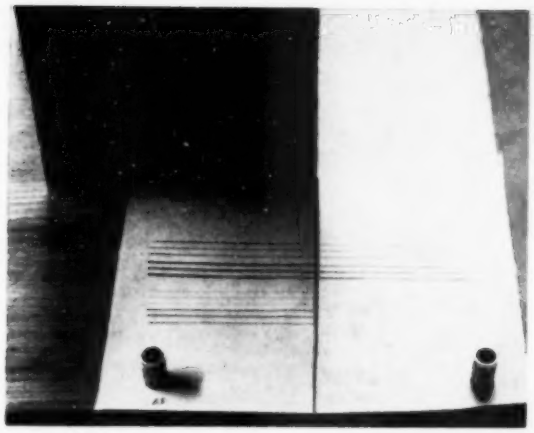


Figure 13. Drafting paper under low brightness sources.

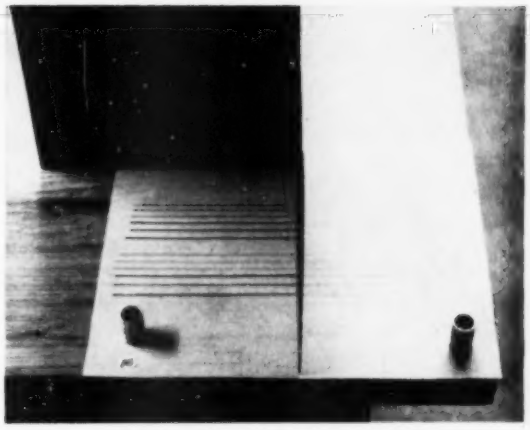


Figure 14. Drafting cloth under low brightness sources.

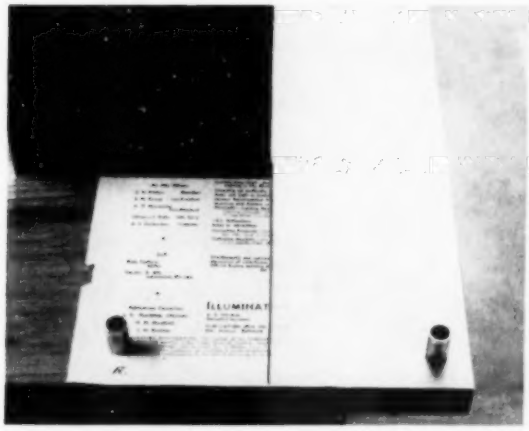


Figure 15. A glossy sample under low brightness sources.

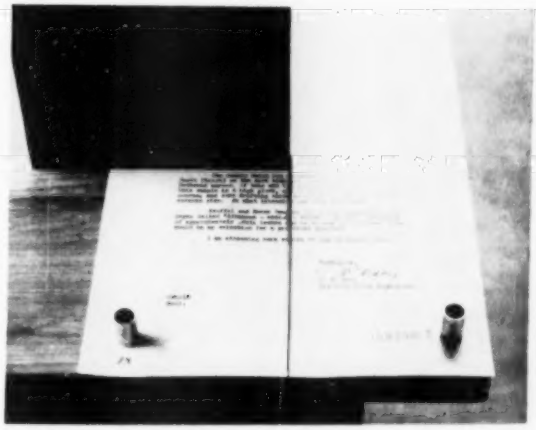


Figure 16. Office bond under low brightness sources.

paper. Fig. 11 is newspaper; Fig. 12 is the varnished, oak table top used in the tests. The level of illumination with the 40-watt T-12 lamps was 21 footcandles. Average brightness was 2,500 footlamberts.

While different pictures are not directly comparable, left and right sides are. There is no evidence discernible from these pictures showing effect of decreasing the brightness of the source. We know that dimage decreases and visibility increases as source brightness diminishes.[1] In view of the limitation of this study, brightness of the source was not considered as a graphic influence. For the interest of the subject, a set of pictures was made using an average brightness source of 450 footlamberts. This was obtained by placing a diffuser between the task and the fluorescent lamp. Figs 13, 14, 15, 16, 17, 18 and 19 were made with this brightness source at a level of 12 footcandles.

Instrumentation

All of these pictures imply the large influence of direction of flux upon dimage and visibility. Accordingly, it would seem reasonable to construct a photo-electric device that would be capable of measuring this phenomenon. With this in mind, a Flectometer, as shown in Fig. 20, was designed using a standard footcandle meter mounted at 45° with a shielded cell aimed at a plane mirror.[2] This assembly was mounted on a circular base divided in 22½° increments. From readings of the meter at each 22½° station, direct meter readings were made. The direct readings were called flects. The flects were then plotted as a polar curve forming a Flecto-Graph, Fig. 21, thereby providing a symbol of direction of dimage. The dimage as measured on a Flecto-Graph is, of course, not truly representative of the dimage of varying papers but it is

Figure 17. Office copy paper under low brightness sources.

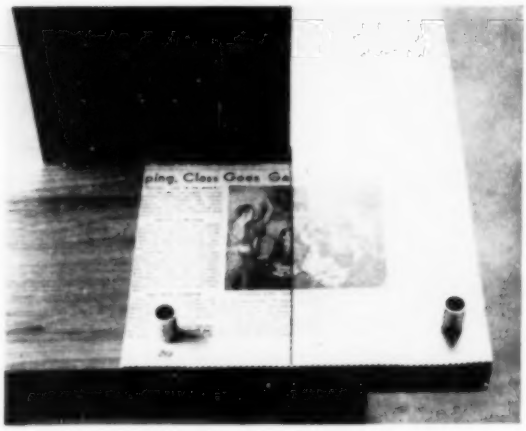


Figure 18. Newspaper under low brightness sources.

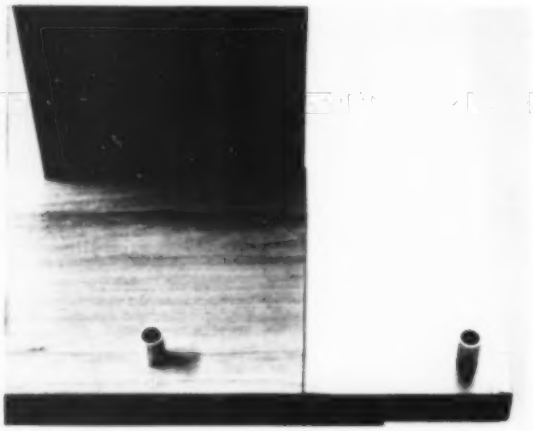


Figure 19. Varnished oak under low brightness sources.

Figure 20. Flectometer with standard footcandle meter.

a measure of the cause of maximum and minimum dimage and all degrees of dimage in between.

Some sort of a mathematical approach seemed advisable in order to record the degrees of dimage. To do this, a ratio of the total flects in quadrants A and B was proposed. This formula could be stated in this form:

$$\text{Dims} = \frac{B}{A}$$

where B = total flects in B quadrant and A = total flects in A quadrant.

Applying the formula to the curve with the light source opposite the eye, we arrive at a dimage of 3.9 dims. Referring to our photographs, 3.9 dims must represent maximum dimage.

Next, let us see what minimum dimage would rate by the same formula. Using the Flecto-Graph plotted from side lighting, Fig. 22, we derive a rating of .27 dims for minimum dimage.

Conclusion

The right angle shield technique permits photographic recording of maximum or minimum dimage on the same plate with a specific task. The pictures made so far indicate the influence direction of flux has upon dimage and consequently, visibility of various tasks.

Most paper surfaces have some degree of dimage, with the gloss types affording difficult seeing surfaces and the matt types showing improvement, but not complete elimination of dimage.

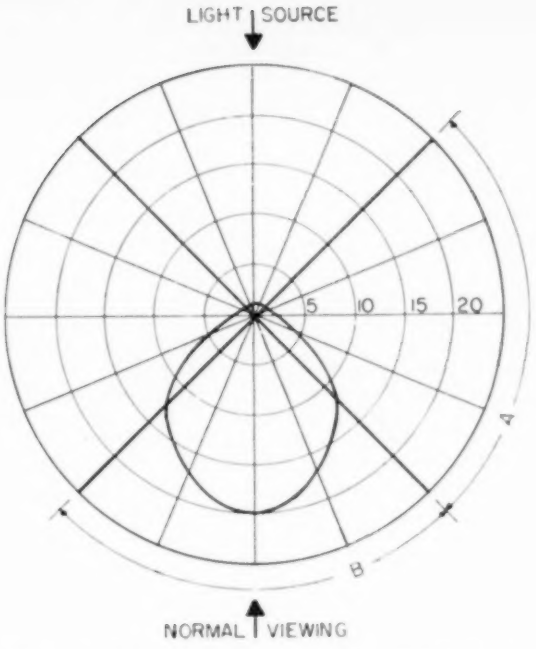


Figure 21. Flectograph with light source opposite the eye

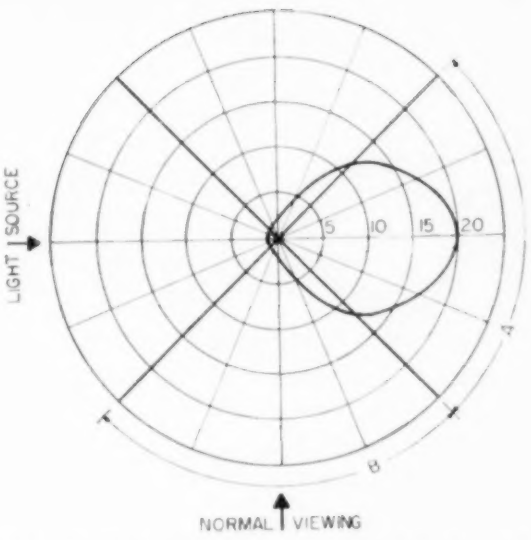


Figure 22. Flectograph with light source at left of normal viewing indicating minimum damage.

An instrument for the measurement of directional flux seems practical with the use of present photo-electric cells. A rating means also seems feasible.

Direction of flux appears to be a powerful deterrent of dimage and as such may offer a challenging and bright future for illuminating engineers. Utilization of direction of flux may also suggest our next field of improvement in quality of illumination.

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1. Sharp, H. M., and Parsons, J. F.: "Loss of Visibility Due to Reflections of Bright Areas," ILLUMINATING ENGINEERING, Vol. XLVI, No. 11, p. 583 (November 1951).

2. Crouch, C. L.: "The Relation Between Illumination and Vision," ILLUMINATING ENGINEERING, Vol. XL, No. 9, p. 776 (November 1945).

DISCUSSION

CHARLES W. MACY*: It is indeed heartening to lighting field men whenever we find a manufacturer's designing engineer who is concerned about what this author calls "dimage." For many years we have known that both incandescent and fluorescent artificial lighting have created a troublesome effect which has caused the great majority of the lighting complaints in both office and school classroom areas. This was true with incandescent lighting long before fluorescent lamps were made available. It was then discovered that by lowering the downward brightness from 0 degrees to 90 degrees and increasing the upward light component, and at the same time distributing this upward light over the ceiling as evenly as feasible, that almost all complaints ceased in office areas when the source brightness did not exceed approximately 333 footlamberts — about 0.6 candle per square inch. The final developments in incandescent luminaires came about over a long period of time — some 50 years — actually by the trial and error method. The many fixture manufacturers kept trying to overcome the causes of customer eye fatigue in order to make their merchandise more desirable. Actually what they were doing was improving the quality of the light by different methods. By 1939 a fairly comfortable compromise had been reached with the luminous-indirect type of incandescent units.

Dimage or whatever causes complaints had been greatly reduced. The author seems to be on the track of something important — perhaps a formula which will be of great value to assure and insure much greater satisfaction for the users in such a tremendous field as the combined fields of office lighting and schoolroom lighting. If the eye is indeed a muscle and "dimage" exercises this muscle unduly, as it would appear, then there must be further relations to consider such as *duration of time* and the *severity of the seeing task*. Probably *color* will enter into such an investigation. Because reading letters and figures has become such an important part of human existence it seems to me that an expanded study on this phase of lighting, which has been commenced so ably by the author, should be insisted upon by the membership of the Society.

Lighting people in general seem to have lost the value of the lesson gained with incandescent lighting. Surely the eyes of the public react much the same to glare and "dimage" as they did before the advent of fluorescent lamps and the year 1939.

Raw and uncontrolled light may produce lots of intensity,

*Pacific Gas and Electric Co., San Francisco, Calif.

but it certainly misses the target insofar as quality is concerned. The sun's beams of light must be well controlled in order to be usable by the human over long periods of time. About the only conditions under which the direct rays of the sun are really comfortable for reading from white paper are those limited minutes directly after dawn and directly preceding dusk, and then only because the haze close to the earth acts as a dense diffuser. If this sort of light is both comfortable and pleasing while the brightness of the source is relatively low, perhaps there are some desirable light characteristics here in nature which could bear further study.

The author calls the elusive culprit "dimage," and it seems to me that there is an unmeasured, and neglected, factor. The author's "dimage" is causing a lot of damage — to both customers' eyes and the lighting business in general. I am pleased to endorse the coined word "dimage."

Interesting as the results of his tests are, there appears to remain a lot more to be learned by expanding these tests. Perhaps two more light sources could be introduced at opposite angles to the two used in the tests. Then perhaps these four sources could be individually expanded until they approach the actual conditions which we find with conventional luminous ceilings.

I notice that the author intimates that there is a need for further studies at different intensities. Because humans and their eye muscles will be directly affected under many different seeing task strains, I hope that the *time* factor will not be slighted in future tests.

It seems to me that the importance of *intensity* as a characteristic of light has been played up entirely out of proportion with the importance of the *quality* of light. Undoubtedly we are all somewhat guilty, both technical and non technical members of the lighting industry. I, for one, am only too pleased to offer whatever support I am able to add to such an endeavor which the author has so ably commenced — a fine start towards comfortable and pleasing seeing conditions for both office and classroom areas.

G. G. RAE*: This paper makes several direct and indirect contributions to the science of seeing. It shows directly, previous papers to the contrary, that reducing the brightness of a light source is not a cure all for improving ability to see. It reminds us that specular reflection is visible and that the viewer automatically adjusts his position to avoid it. "Dimage" being diffuse and not recognized reduces our seeing ability in a hidden subtle manner.

Indirectly, Mr. Wakefield's tests show that it is reflected flux rather than maximum source brightness that causes dimage. A high dimage results from the product of the candlepower toward the direction of the work and the solid angle subtended by this source. Here is another reason why average rather than maximum luminaire brightnesses give an evaluation of their performance.

Mr. Wakefield properly gives only a tentative mathematical evaluation of dimage since there is a question whether the total "flects" in a quadrant give an evaluation of dimage rather than the ratio of the maximum to the minimum individual "fleet." Furthermore, as far as quantitative measurements are concerned, the author gives no means of adding the dimage from several sources in the field of view.

Directional control of flux, for example by reducing longitudinal flux in extended light sources, has already been applied with success. Further investigations in this field are desirable to aid in the design and evaluation of high level comfortable lighting systems.

JOHN J. NEIDHART*: Mr. Wakefield is to be commended for his very striking method of illustrating how serious reflected glare at its worst can be. We often fail to realize the magnitude of veiling effects in a given lighting installation because we unconsciously dodge these reflections to improve visibility. As we increase the number of sources in a given room, however, it becomes more and more difficult to dodge a veiling reflection; and when this addition of sources is carried to the extreme condition in which the entire ceiling is the source, we find it impossible to dodge the reflection. On the other hand, the addition of sources or luminous areas which are contributing illumination on the task without being reflected toward the eye are tending to improve visibility or lessen the veiling effect. It is apparent, therefore, that we are dealing with a very complex subject which in this paper is oversimplified somewhat by limiting the comparisons to a single non reflecting source and a single reflecting source.

The complexity of the reflected glare problem is further illustrated by the fact that his photographs seem to indicate that there is no advantage in decreasing the source brightness from 75,000 footlamberts to 450 footlamberts. As Mr. Wakefield points out, however, we know that it is advantageous to reduce the source brightness, and I believe that the apparent inconsistency in the photographic evidence may be at least partly attributed to the differences in illumination level with the various sources and photographic variables that are difficult to control. Mr. Wakefield cautions us not to compare different photographs for this reason, but I would like to tell you that a somewhat similar photographic investigation made by another member of the Office Lighting Committee shows that with the illumination level held essentially constant, the veiling effect of source brightnesses ranging from 150 to 50,000 footlamberts bore no apparent relationship to the 1 to 300 range in brightness. The veiling effect was always present and always objectionable.

The idea of so locating luminaires with respect to the task that reflected glare would be minimized was introduced by Kahler and Larson in 1945. Their functional technique of lighting small offices with one or two occupants has since received wide acceptance and is recommended in the 1947 Recommended Practice for Office Lighting as one means of preventing reflected glare. This paper bears out the validity of that recommendation.

WILLARD ALLPHIN**: I should like to congratulate the author on an interesting improvement in photographic technique for showing veiling glare. However, I question the desirability of adding four new words to our already overburdened language for the purpose of dealing with this subject.

Also, I wonder if the so-called flectographs in Figures 21 and 22 tell any more than would a simple ratio of specular reflection to diffuse reflection for the surface in question. It seems to me that in an actual lighting situation with multiple sources the curves would lose their significance. For example, in a large room with a luminous ceiling would

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*Lighting Engineer, Westinghouse Electric Corp., Cleveland, Ohio.
**Sylvania Electric Products Inc., Salem, Mass.

not the curves for both glossy paper and matte paper produce similar circles centered on the center of the chart?

H. L. Logan*: This paper is a nice piece of work and the author is to be congratulated on the clarity and simplicity of the method he has adopted to pin down reflected ceiling glare. The paper is also an interesting illustration of the fact that when light strikes a surface a portion of it is reflected unchanged, while the rest penetrates the surface and is returned modified. It is by the latter light that the details and characteristics of the surface are made visible. Therefore, what the author calls "dimage" is a characteristic of the receiving surface, rather than of the light source; and the extent to which "dimage" is a defect in the field of view, it is a defect *of* the field of view, rather than of the light that is illuminating the field of view. It can, as the author points out, be turned in harmless directions by suitable control of the direction of the light to the surface; and that is often a practical answer.

However, the long run solution of the reduction of "dimage" is through correction of the surfaces used in the field of view. Surfaces that develop too much spread reflection should be avoided by the intelligent choice of surfaces that do not do this. Where such surfaces are not available they should be made available, and as a practical fact, that is what is gradually happening. People used to delight in using glossy desk tops, both in school and in the work world. Dull finished desk tops are now the rule rather than the exception. The finishes on the latest lines of metal office furniture produce very little "dimage." The paper people are also working on this and better papers are becoming available (as well as worse papers in cheap products). Surgical instruments, control board equipment, network analyzers, and all kinds of things are now being provided with the kind of dull finishes that reduce "dimage."

It is a long process because it means educating the manufacturers of so many different products, and it may still be going on fifty years from now; but it is the only fully satisfactory answer to this particular problem.

The attempt to eliminate "dimage" by altering the characteristics of lighting units in the direction of more and more diffusion is illusory. If a surface will reflect light in a "spread" fashion it will do it no matter how the light comes to that surface. If there is a dominant direction to the light, as is usually the case with natural lighting, owing to its proceeding from one lighting unit — the sun, the "dimage" axis will be in line with the dominant direction of the received light. If the light — to go to the other extreme, and thought by some to be ideal — is completely diffused, the "dimage" will now occur in all directions. If the nature of the surface is such that the percentage of surface reflected light is equal to, or greater than the penetrating reflected light, one will see only light, and no surface details at all. That is, without correction of surface reflecting conditions complete diffusion can lead to complete invisibility.

The ideal surface, from the viewpoint of this discussion, would be one that had no surface reflection component, but permitted all light that struck to penetrate and be reflected, after modification by the material. The details of such a surface would then be seen best under natural lighting, or under any lighting having the "dominant" direction that Dr. Luckiesh stressed so frequently. This would even be true for printed letters on paper, as the letters have three dimensions. They are usually about one sixth the thickness of the paper, and to light waves they are mountains on the paper which, properly lighted, can throw their shadows to increase their apparent size and legibility, under the proper conditions.

The author is to be complimented on his ingenious attempt to quantify "dimage" and his concluding observation that "Direction of flux appears to be a powerful deterrent of dimage" is recommended to the consideration of engineers generally. It re inforces Dr. Luckiesh's advice that artificial lighting should have a dominant direction just as natural lighting has that we are adapted to.

C. L. Cottrell*: It is of course important to be concerned about how the incident light flux on a visual task may affect the "visibility" of that task, and this paper reports an interesting approach to a study of this question.

A few questions may be asked about this paper, as follows:

(a) Has the author compared the photographs with the actual visual appearance in each case? A direct similarity would depend upon the particular response of the emulsions of the negative and of the print, since in general the contrast gradient of the resulting print may differ widely from that as seen directly by the eye.

(b) How may the "flectometer" be effectively used for a particular paper? It seems that there might be difficulties with getting the meter itself in the way of the incident flux. Here one might also ask about the use of the meter for any angle of incidence from the source other than 45 degrees, but retaining a viewing angle of the task of 45 degrees.

(c) Might there be more justification for the author's choice of his B/A ratio as he describes his measure of "dimage"? Why should he add the "flects" of angles beyond those actually present when a source illuminates a task in either the side or forward position? It seems possible to get equal values of this ratio for each of two different sources which in fact produce different veiling glare effects, depending upon the different distributions of flux from the two sources. Would the central 30 degree zones in each quadrant give a more informative index?

R. L. Biesele, Jr.**: Mr. Wakefield's attempt to pin down numerically another of the many factors affecting the quality of a lighting system is laudable. Offhand, however, there appears to be little advantage to the use of the mirror with the cell facing downward, as compared with facing the cell upward at 45 degrees and thus eliminating one possible dirt collecting surface in the path of the light. In addition, it would appear reasonable to expect that minimum "dimage" would occur with the light source behind the observer, rather than at the side, although this would have been more difficult to photograph.

The most significant point brought out by the photographs is the effect of overhead brightness opposite the eye, even when that brightness is quite low. Mr. W. E. Folsom and I observed with interest some years ago a room with luminous indirect fluorescent lighting in which the ceiling brightness was almost uniform, and which would be typical also

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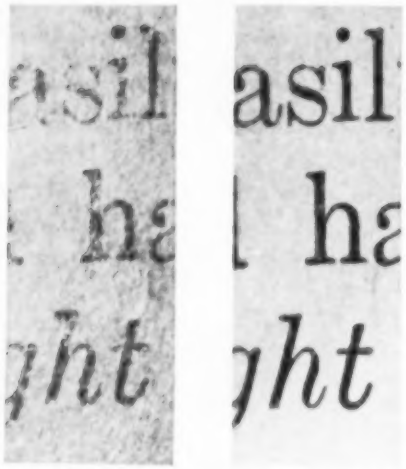

Fig. D-1. Appearance of 12-point printing on fairly glossy book paper. An R-40 lamp about three feet away was directed onto it at 60 degrees from normal.

Fig. D-2. The set-up of Fig. D-1 was not altered, but another lamp placed at the side for added illumination. The increased paper brightness made a shorter photographic exposure necessary.

of the newer translucent luminous ceilings. In this room no orientation of the observer and of a visual task with some specularity was possible which did not produce noticeable "dimage." An adjacent room, lighted with indirect incandescent equipment, had a spottty ceiling brightness pattern, and with this pattern it was possible to so orient the work that less "dimage" was observed when the darker ceiling areas were reflected in the task, than had been observed in the room with uniform brightness ceiling. Least "dimage," however, was obtained for proper orientation of observer and task, in a room lighted from the side wall. In this case, the wall lighting was daylight, but it could have been any form of wall lighting.

It should be emphasized, however, that "dimage" is not always bad, although it is almost universally so for two-dimensional tasks such as those used by Mr. Wakefield in his photographs. In modern street lighting practice, however, it is precisely this "dimage," or specular reflection of light toward the observer, which is relied on to produce the road surface brightnesses which are needed for visibility at the low illumination levels employed. It is also true that vision in many industrial tasks is aided by specular reflections from the surfaces viewed — for example, detection of scribing marks or scratches on metal surfaces. Consequently, "dimage," which connotes decrease of visibility, may not be the best term for the phenomenon Mr. Wakefield has investigated.

The phenomenon is important, however, and should be subjected to some such numerical scale as he has indicated.

PHELPS MEAKER and W. S. FISHER[*]: Mr. Wakefield has taken an interesting line of approach to his subject. He has isolated one manifestation of specular reflection — the reduction of contrast, which is well illustrated by the photographs. We believe that much can be learned from pictures such as these; careful control of the photographic processes will be necessary to produce data of quantitative value.

The matter of angular size of source should be noted in evaluating the pictures, since size is believed to have a substantial effect upon the measureable brightness of semi-specular materials. The diameter of the PAR-38 lamp at the distance used and the diameter of the T-12 fluorescent lamp at its distance probably subtend about the same angle. However, the T-12 lamp is long and performs as a larger angular size than the PAR-38. The introduction of a diffuser to produce the low brightness source again increases the angular extent of the source to an unknown degree. This may be a step in explanation of the absence of marked differences in dimage with sources of reduced brightness.

If the light source were a point and the material a fairly glossy magazine paper, for example, only those facets in the surface of the paper and ink which were oriented to reflect light into the eye would appear abnormally bright. If the angular size of the source were increased, additional facets would begin to reflect, with the ultimate possibility of the entire ink character becoming as bright as the paper, with complete loss of contrast.

The accompanying illustration, Fig. D-1, shows that dimage is made up of the reflections from many minute surfaces. This photograph was made with a 150-watt R-40 lamp about three feet away shining at 60-degree incidence upon the paper. The camera lens was about three inches from the paper. Since a very small lens aperture was used, it is believed that the number of specks indicated is substantially the same as would result were the eye at fourteen inches, about normal reading distance. The reflecting facets in the ink reduce contrast; increases in paper brightnesses up to a certain extent tend to improve contrast.

This is what has occurred in the second illustration, Fig. D-2, where paper brightness has been increased by light from another R-40 lamp located at the side. Some of the specks have apparently disappeared, because, in comparison to the increased paper brightness, they no longer seem bright. The photograph is a good representation of the change in actual visual appearance.

It would seem that less dimage than Mr. Wakefield's minimum might result if the light source were placed behind the viewer. However, if the data of Fig. 21 are applied, this condition appears to result in about 0.34 dims, somewhat higher than the 0.27 dims found for the source located at one side. Does this seem reasonable?

One would hesitate to apply the dimage formula in evaluating a lighting system where many sources were present. However, purely for conjecture, if one were to plot a flectograph for a luminous ceiling at the center of a good-sized room, it would be approximately a circle. Then applying the formula, the dims would be equal to 1. Does the author think this indicates a fair location of luminous ceilings between the maximum and minimum dimage conditions for which calculations appear in the paper?

In consideration of the points raised above, perhaps the expression for dimage should be modified to allow for the improvement resulting when additional light falls upon the work from a direction which does not materially increase the specular reflection in the eyes of the viewer. The "A" region could be extended to include the quadrant opposite the viewer and/or to include flects from both sides instead of from only one.

Of course, the characteristics of reflecting surfaces must share the blame for a part of the dimage. If one is

[*]General Electric Co., Nela Park, Cleveland, Ohio.

astonished at the evidence of dimage from newsprint or bond paper, it is only necessary to examine such surfaces under a strong magnifier. Even blue prints have minute reflecting facets which were found to be glaring under a high intensity shielded lighting installation in Chicago.

GEORGE P. WAKEFIELD*: It is indeed encouraging to hear the kind remarks of Mr. Macy. This gentleman from the West has had a lot of practical customer experience in the reflected glare zone and has found that a limit of 333 foot-lamberts in this zone prevents customer complaints. Whether or not these reactions were from dimage or discomfort glare, I do not know. Presumably, they were from reflected bright spots on specular office equipment rather than from dimage at the seeing task. This, of course, represents a different problem than dimage but it also could be improved by the control of direction of flux.

From the studies in this paper it appears as though optimum visibility can be obtained only by the use of directional flux control. Is it not in order to ask then, why has not more progress been made in this phase of quality? I think there are three obvious reasons:

(1) Dimage is difficult to detect, by Mr. Macy's customers, for instance.

(2) Many illuminating engineers know the advantages of flux control but hold up their hands in horror, along with everyone else, at the thought of orientation of luminaires to the task.

(3) We have been too busy concentrating on direct glare. I realize the direct glare is a problem but not so important that the visibility at the task be ignored completely. Our progress has been too cyclic and fadish.

Perhaps if the real worth of optimum visibility is fairly assessed orientation will not appear such a stumbling block. I cannot see the impracticability of an illumination scheme that provides the maximum visibility at the task. A simple and everyday occurrence of this is the window with daylighting!

I will agree with Mr. Rae that a low surface brightness in the reflected glare zone is not a cure all. Mr. Macy has found it to be a big improvement though to the ordinary user; perhaps it is a suitable part time measure — that is, a means to carry over until orientation comes to practice.

Mr. Rae can visualize the value of a simple and easily obtainable symbol of reflected flux at the task, I venture. If it can be coordinated to visibility and standardized like the footcandle, we would then be at the threshold of a new era in illumination. Mr. Stiles in a recent I.E.S. Transactions (London) states, "The aim of lighting is to make seeing easy. It would greatly assist the lighting engineer trying to achieve this if he could determine a quantity which would give a numerical measure of his success." I believe my paper illustrates in a simple way that this is feasible.

I appreciate Mr. Neidhart's remarks and agree with him completely. The Kahler and Larson Paper of 1945 suggests the use of functional orientation as an aid to small office lighting. If it is good for small offices, it is good for all offices. Seeing knows no demarcation.

Mr. Allphin need not worry about four new words being added to our already overburdened language, as I am merely suggesting them. The only danger, as I see it, is if they are necessary for future illuminating engineers they might be used.

*Author.

The flectometer is never used with paper, consequently, Mr. Allphin's last question cannot be answered directly. I will say, though, that a flectograph of a luminous ceiling would be circular if you were in the center of the ceiling, and it would be off-center or lop-sided if you were taking readings near the room side. This effect would range from one dims to more or less depending on the dominant character of the flectograph.

Mr. Logan believes that the answer to excessive dimage comes from improved papers. I agree with this explicitly but wish to say that we will still have dimage even with matte papers. Further, matte paper cannot be used for all paper requirements; hence this proposal is not a practical answer to dimage reduction. My paper suggests, if we are to obtain paper task visibility near 100 per cent, we must look to lighting — not to paper.

In reply to Dr. Cottrell, visual comparisons were made of each test prior to photographing. These checked surprisingly well with the photographs. The inaccuracies of response of emulsions of the negative and the print are not felt to be great enough to destroy the intent of displaying the difference between maximum and minimum dimage on a photograph.

Some justification of using all flects in the 90-degree zone comes from a workable tolerance required for head and source variations from the normal position. Whether or not this is the correct latitude for an information index is not definitely known. Considerably more tests in the field would be necessary to answer this question.

To Mr. Biesele I would like to say the use of the mirror in the flectometer is mostly psychological. It is realized the mirror in the flectometer allows the operator, who may be a layman, to visualize the cause of dimage in a clearer way.

The flectographs in the paper bear out Mr. Biesele's room experience. As ceiling brightnesses lower, dimage decreases as in the case of the side wall lighting mentioned. Carrying this illustration one step further, optimum visibility would be attained if the ceiling were painted black.

I will agree with Mr. Biesele that dimage (or reflected glare) improves visibility on highways and metal surfaces. My definition, though, is confined to the "Diffused image that dims (or lowers) visibility of the seeing task."

I quite agree with Mr. Meaker that the angular size of the source has a direct effect upon dimage. This factor as Mr. Neidhart suggests, makes the whole problem rather complex. As a final evaluation perhaps the flectographs should be coordinated with the Cottrell brightness-contrast meter in such a way as to indicate percentages of optimum or 100 per cent visibility.

Mr. Meaker's accompanying photographs show an enlarged view of dimage. Unless one is using specular paper, the dimage would not be visible to the layman. This, of course, does not mean it does not exist but helps to demonstrate why it is not a popular complaint.*

*An interesting observation along this line appears in the British "Lighting of Office Buildings." In the appendix there is a table tabulated from answers given by typical office workers to the query, "What is wrong with the position of the lights?" Of them, 9 per cent stated the lights were too high, too far away, 5 per cent complained of lights behind (shadows), 8 per cent said lights were needed over work, 3 per cent mentioned lights were needed behind, 2 per cent said a desk lamp was needed, 73 per cent said nothing was wrong!

This seems to disprove my complete paper in removing the degree of importance from the subject, yet I feel the average office worker is inept to serve judgment on the problem. This is the main purpose of the paper, to focus attention on the subject of reflected glare.

Consideration of back lighting was rejected due to expected shadow problems.

Luminous ceilings would rate a 1 dims by the flectograph formula. In general, indirect luminaires would rate about the same. Mr. Meaker asks me next to rate my rating plan. This reminds me somewhat of other rating systems using numerical figures. They are difficult to evaluate. I believe the answer lies in the Cottrell meter.

It seems to me if we are to attain the quality of illumination we seek at the task, we have two distinct means at our disposal: (1) The low brightness method of minimizing reflected glare. (2) The orientation method of flux control.

Opposite these suggested forms we have a considerable disregard for these two principles which seems to represent a large portion of present day lighting concepts. In general, these two classifications fulfill most of the paper requirements. One deficiency of the low brightness technique comes to attention when specularity is great, then orientation is the appropriate practice.

Flexible Lighting System for a Country-Club Dining-Room

A flexible lighting design permitting severals of illumination was desirable for the dining room and bar of the Salem Country Club, Peabody, Mass. Since the view from the picture windows and French doors was one of the features of the room, the lighting was designed to blend well with daylight and yet not distort the colors of foods and beverages at night.

Four prismatic glass luminaires with curved lenses, flush mounted in the 8 foot 3 inch high acoustical tile ceiling, each contains three 48 inch single pin deluxe warm white lamps. The lamps are switched on two circuits so that the center lamp of each unit can be used alone for conversation lighting, the two outer lamps for a higher level and all three for maximum illumination.

To provide a low level near the long inner wall, two 12 foot coves of Alzak aluminum, painted on the outside to match the wall, were installed, with the top of the coves 7 feet above the floor. Each contains three 48 inch bipin warm white lamps mounted end to end. For the opposite curved exterior wall a valance was designed 8½ inches high, 6 inches from the wall and mounted high enough to clear the screens, which open inward. Architect, carpenter, electrician, decorator and lighting engineer worked together to provide a dual lighting system behind the cloth covered valance. Two rows of 36 inch fluorescent single lamp channel back to back above and below the valance supports, are on separate controls permitting upward lighting to balance the coves or down lighting on drapes and tables, or both.

Luminous scenic pictures utilizing edge lighting plus lumiline lamps which provide upward and downward light tie the short end walls together. Existing pin point spot lamps were retained in the recesses of the back wall of the bar and two recessed prismatic lens units were installed above the bar counter.

This installation won an honorable mention for C. M. Holden, Champion Lamp Works, in the 1952 contest by the New England Section, I.E.S. for "My Most Interesting Lighting Job." Electrical Contractor was J. Conway Electric Co.

Characteristics of Alzak Aluminum As Used in the Lighting Industry

By HERBERT LYONS
WILLIAM WEIBEL

THE ALZAK process for finishing aluminum reflectors consists primarily of surface preparation of the metal, brightening, formation of aluminum oxide and sealing of the surfaces. The process was developed by the Aluminum Company of America about 20 years ago and licenses have been issued to companies here and abroad covering their use of the process.

Reflector Sheet

Alzak specifications are based upon the use of a special alloy called "reflector sheet." The essential requirement of such aluminum is that it be of high purity. The presence of even a small amount of impurities is usually unsatisfactory as the processed reflector may exhibit unsightly streaks of these impurities and will have a dull surface of reduced reflectivity.[1] The presence of silicon, for example, causes a definite darkening of the surface and for this reason the Alzak processing of sand castings is not practical where appearance is a major consideration.[2]

The reflector sheet used for a diffuse surface is of high purity and is homogeneous throughout. The reflector sheet used for a specular surface has a coating of special, higher purity aluminum on one side. Each of these two type sheets is available in various tempers suitable for forming, drawing, spinning, stamping, etc.

Fabrication and Handling

It is desirable that all fabrication of the reflectors be completed before processing.[2] This insures that all cut edges, sharp bends, inside of holes, etc., will receive the same benefits of the process as do all of the other surfaces of the reflector. The resulting surface of such a processed reflector will be smooth, hard and unbroken. Tight beads or folds are usually avoided so processing solutions will not be retained in them. Tools and dies are designed and used so as to produce reflectors having a minimum of tool marking. The chemical etching of surfaces of diffuse reflectors will mask only a small amount of such marking. The Alzak process, unlike plating or painting, does not deposit material on the reflector surface and so does not mask tool marks.

In handling the reflectors through the various stages of the process it is necessary that they be securely held so as to avoid damage and to insure good electrical contact. Typical racks make use of clips or prongs to hold one or more reflectors. All rack parts, including nuts, bolts, screws, etc., which come in contact with the processing solutions, are of aluminum so as to avoid contamination of the various solutions. The anodic coating (aluminum oxide) which is formed in the final stages of the process covers all surfaces of reflectors and racks. This oxide coating on the racks is heavy enough to form a good insulator. This must be removed from those rack parts which are to make contact with the next reflectors to be processed. This is done mechanically by means of a file or hack saw or, more easily, by immersing the rack in a chemical solution to dissolve the anodic coating. Air hoists on an overhead

Flow Sheet for the Alzak Process

Diffuse Reflectors	Specular Reflectors
Fabrication	Fabrication
Racking	Racking
Clean and etch	Clean
Rinse	Rinse
Clean in acid	
Rinse	
Electrolytic brightening	Electrolytic brightening
Rinse	Rinse
Smudge removal	Smudge removal
Rinse	Rinse
Formation of aluminum oxide	Formation of aluminum oxide
Rinse	Rinse
Seal	Seal
Dry and unrack	Dry and unrack

AUTHORS: Curtis Lighting of Canada Ltd., Toronto, and Curtis Lighting Inc., Chicago, respectively. Paper submitted by the Chicago Section Papers Committee.

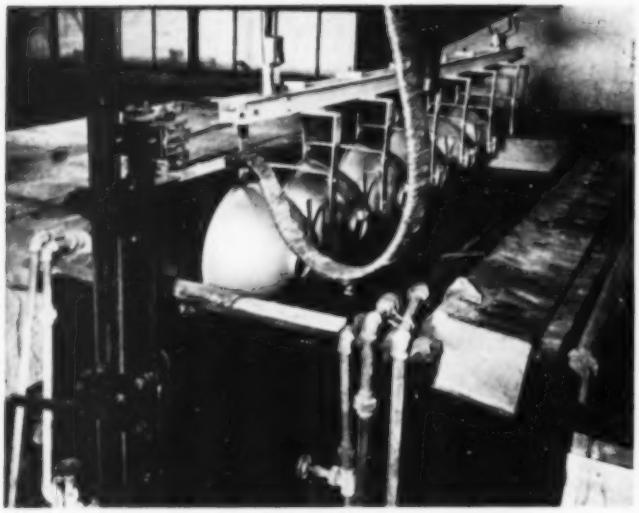

Figure 1. Reflectors and rack being lowered into the electrolytic brightening tank. The clamp stand in the foreground connects the rack to electrical supply.

Figure 2. A rinse tank with spray. The weight of the rack actuates the valve which controls the spray.

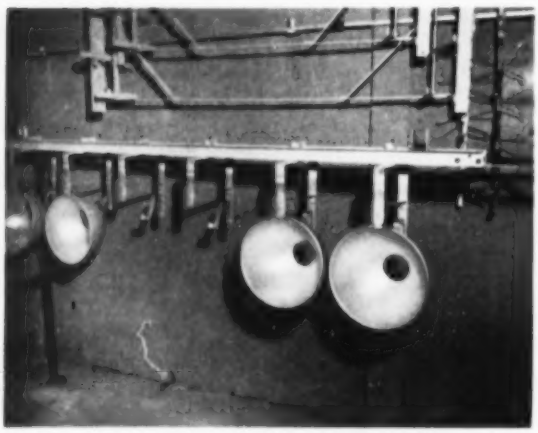

Figure 3. Rack detail for typical incandescent reflectors.

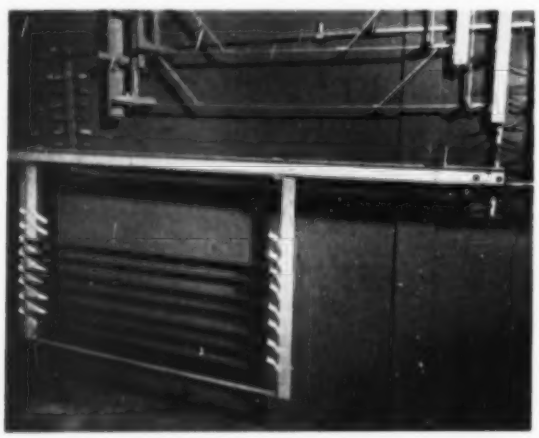

Figure 4. Rack detail for typical fluorescent reflectors.

rail system have proved very useful in the handling of racks throughout the process.

Surface Preparation

The aluminum sheet as usually furnished by the rolling mills has a very smooth, specular surface. This roll finish is unsatisfactory for processing unless the surface is first cleaned and prepared. The imbedded impurities and any surface film of oil, grease, etc., must be removed. The reflectors which require a diffuse surface are immersed in a solution which chemically etches the surface. Those reflectors which require a specular surface are made of sheet having the one side coated with the special, higher purity aluminum. This surface is polished and buffed and then cleaned in suitable solutions. The special coating is very soft at this stage and may not be mechanically cleaned to remove any material which had been used in the drawing, forming, spinning, polishing or buffing of the reflector.

The many stages of the Alzak process require a variety of solutions, some alkaline, some acid and one which is essentially pure water.[3] Such solutions must be maintained at correct strength and "carry-over" of dissimilar solutions, from one tank to another must be avoided. For this reason, single or double rinses are used between each stage of the process. The addition of spray nozzles along the top edge of rinse tanks greatly improves the rinse. In order to conserve water, these sprays are controlled either manually or automatically so that they are in operation only while work is being passed in or out of the tank. All rinse tanks have

overflow pipes so that there is a continuous supply of fresh water.

The first of the two electrolytic stages of the process is that for brightening the reflectors. After the reflector surface has been cleaned and prepared for diffuse or specular finish, it is immersed in a tank of acid solution and connected to the electrical supply. Current density, acidity, temperature and time are carefully controlled, and all surfaces of the reflector in contact with the solution are electrolytically brightened.[1] This stage is essentially a deplating operation, with a thin film of metal being removed. Also removed are any such impurities as dirt, polishing and buffing material, etc. which may have remained on the surface after the initial cleaning and preparation described above. There must be no motion of the rack, reflectors, or solution during this stage as such motion will result in a cloudy surface on the reflectors. After the electrolytic brightening stage, there is a very thin film of oxide upon the surface of the aluminum. This film, if allowed to remain, would appear as a soft and chalky coating on the surface of the finished reflector and would smudge with handling. This thin oxide film is removed by immersion in an acid solution commonly referred to as a "smudge removal" solution. Electrolytic brightening is an essential and distinguishing feature of the Alzak process. The usual "anodizing" of aluminum parts is primarily for surface protection and does not include surface brightening.

Aluminum Oxide Formation

The reflectors with surface cleaned, prepared and brightened are then ready for the second of the two electrolytic stages of the process. Here again the current density, acidity, temperature and time are carefully controlled. In this stage, aluminum oxide is formed from the aluminum itself and covers all those aluminum surfaces which are in contact with the solution and are carrying current. Unlike a plating operation, no material is deposited on the surface.

The first oxide formed is on the outer surface of the aluminum. It grows in thickness only if the aluminum sheet under this oxide layer is exposed to the action of the current and the acid solution. As described by Edwards,[4] this is possible because, although the oxide is a non-conductor, there must be many small pores in the oxide surface which permit the acid solution and current to continue to reach the aluminum and form more aluminum oxide.

After formation of aluminum oxide to the desired thickness, the multitude of small pores must be closed. If this is not done, the surface of the aluminum would be highly absorptive and its initial

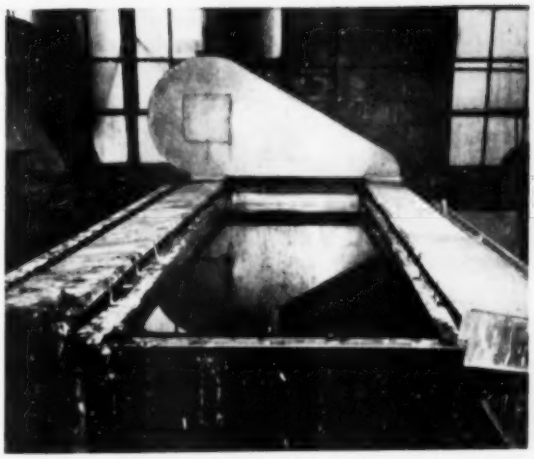

Figure 5. Typical tank, complete with ventilating ducts.

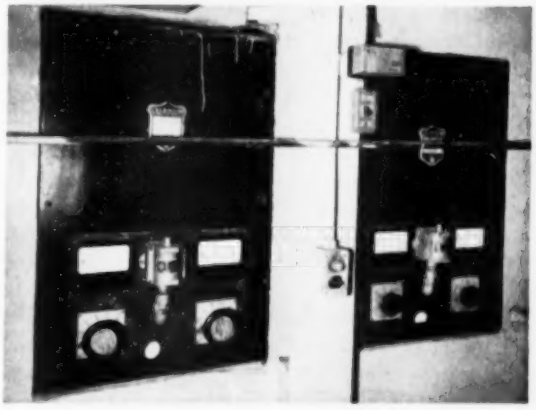

Figure 6. Control panels for rectifiers, controlling power used in electrolytic brightening and in the formation of aluminum oxide.

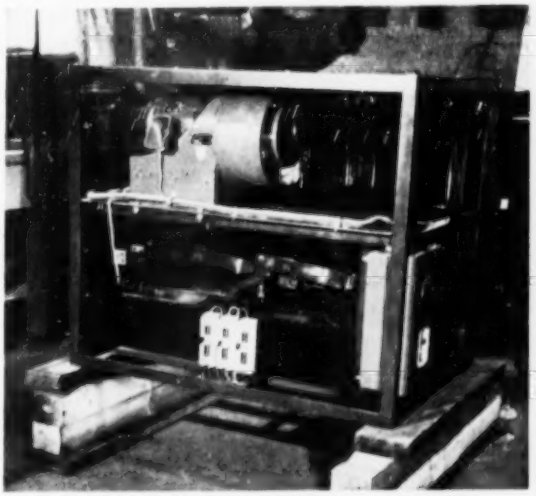

Figure 7. Rectifier detail. Each rectifier approximates a four-foot cube and weighs 1500 pounds.

reflectance could not be maintained. The sealing of the surface of aluminum reflectors is accomplished by immersion for a length of time in hot water. The hot water converts some of the aluminum oxide to aluminum monohydrate, with probably some increase in volume, which serves to close the pores.[2] Distilled water or deionized water is most desirable, although tap water may be used if care is taken to remove or neutralize alkalines, acids, chlorides, etc. which are sometimes found in undesirable amounts.

The drying and unracking of the reflectors is the final stage of the process. The resulting finish is smooth, hard, continuous and with proper maintenance, its reflectivity will be retained with little or practically no permanent reduction.[5]

Electrical Requirements

The process may utilize either generators or rectifiers as the source of the required direct current potential. The maximum voltages required are 35 volts for the electrolytic brightening and 25 volts for the formation of the final thickness of aluminum oxide. The total current to be supplied is determined by the current density required and the exposed surface area of all reflectors and racks used at any one time. The electrolytic brightening stage requires a maximum current density of 20 amperes per square foot and the formation of the final thickness of aluminum oxide requires 12 amperes per square foot.[3]

The tanks are of wood or metal depending on the type of solution. Stainless steel, because of its resistance to attack by chemicals, is preferred.

Some of the tanks, for other than rinsing, are fitted with air ducts to remove fumes. Several are fitted with suitable means for agitation of the solution. A typical arrangement utilizes compressed air and perforated coils immersed in the solution. Agitation is required to insure a uniform distribution of temperature throughout the solution.

Reflector Characteristics

The final reflector may have any of a wide range of distribution and service characteristics depending on its design and processing. The reflector contour and the type and size of lamp to be used are major factors in determining the type of light distribution. The contour also determines the brightness of the reflector as viewed from various angles. However, the finish of the reflector surface also markedly affects the final distribution and brightness of the reflector.

The Alzak process provides the means of producing reflector surfaces ranging from very diffuse to very specular and with surface protection suitable for interior or exterior use. The diffuse reflector, with surface chemically etched or mechanically roughened, scatters the reflected light more and in general, results in a wider light distribution and brighter reflector as seen from most angles. The specular reflector, with surface smooth and polished, re-directs most light in a closely controlled beam or cone. The surface of such a reflector, through certain wide angles, has very low brightness. This directional effect of aluminum reflector brightness is very useful in reflector design where viewer comfort is a prime consideration.

The reflection factor of the final surface is dependent on the purity of the aluminum sheet, the cleaning and preparation of the surface, the electrolytic brightening and the thickness of the aluminum oxide.[6] The finish recommended for interior use results in reflection factors in the practical range of 75 per cent to 80 per cent for diffuse surfaces.[3] The range for specular surfaces is approximately 83 per cent to 86 per cent. The higher reflection factor of the specular surfaces, for the same thickness of aluminum oxide, is due largely to the higher purity of the aluminum surface but also, to a lesser extent, because the specular surface "traps" less light due to absorption than does a diffuse surface. With increased thickness of aluminum oxide there is increased absorption of radiant energy and consequent decrease in reflection factor. Reflectors intended for use out-of-doors and with no protective glass cover should have a greater thickness of aluminum oxide for increased protection. The resulting reflection factors are in the practical range of 65 per cent to 70 per cent for diffuse and 78 per cent to 83 per cent for specular surfaces.

The thickness of the oxide, within limits, varies with the current density and time of the processing.[2] For use on reflectors, such thickness is in the practical range of approximately .0001 to .0003 inch. The .0001 inch thickness, representing approximately 5.0 milligrams of aluminum oxide per square inch of surface, is typical of that recommended for most reflectors which are to be used indoors. The .0003 inch thickness is typical of that recommended for reflectors intended for use out-of-doors and with no protective glass cover.[3]

The aluminum oxide surface, properly sealed, is hard, smooth and resistant to abrasion and corrosion. This protection, within limits, increases with thickness. The oxide, having been formed from the aluminum sheet itself, is firmly a part of the sheet and can not possibly peel or separate from it.

Maintenance

Alzak aluminum reflectors, for continued satisfactory service, must be properly maintained. This is particularly important where service conditions

are severe and result in rapid accumulation of dirt, soot, or similar material on the reflecting surface. Neglect in periodic cleaning of the surfaces may result in permanent damage to the reflectors. In cleaning the reflectors, it is recommended that mild soaps, household type detergents, etc. be used.[3] Harsh caustic or acid cleaners must not be used as they will attack the finish.[7] The reflecting surface may be maintained at or very near the initial reflectance if proper cleaning materials and methods are used at the necessary time intervals.[8]

Summary

The Alzak aluminum process, with its wide range of controlled conditions, makes possible the production of reflectors suitable for a variety of applications. The diffuse or specular surface, the reflection factor, the brightness, and the oxide thickness of the surface may be selected for the intended service. The process is not a plating of aluminum as no material is deposited on the surface. The aluminum oxide is formed of the base sheet and cannot part or peel from the sheet. The final surface of aluminum oxide is clear, colorless, smooth, hard, continuous, non-porous and resistant to abrasion and corrosion. The surface, with proper maintenance and use, will remain at or very near its original condition.

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EDITOR'S NOTE: This is the fourth in a series of articles on the characteristics of materials used in the lighting industry. "Characteristics of Plastics," "Characteristics of Porcelain Enamel," and Characteristics of 300 Degree White Backed Enamel Finishes" were published in the December 1951, July 1952, and February 1953 issues respectively. Future articles may include glass and acoustical materials, etc.

Underpass Lighting With Fluorescent

One of the first underpasses in the country to be lighted with fluorescent street lighting is Osage underpass, Fort Wayne, Indiana. The new installation consisting of 20 8-foot-long fluorescent units provides an illumination of 2.5 footcandles. The mounting arrangement of the units on the inside of the abutment and under the steel cornice of the underpass has reduced breakage due to vandalism from 12 per cent with a previous installation to a fraction of one per cent. ***Photo courtesy General Electric Company, Schenectady, N. Y.***

Super Market Lighting for Atmosphere

IN HILLMAN'S Super Food Mart, Chicago, the architectural necessity of dividing the store into two main parts and the desire of the owner for a special atmospheric treatment of one portion, to be used as an arcade type sales area, resulted in a lighting installation of unusual design for a super market. A wide selection of lighting equipment and a generous use of color were combined to form a well-executed and attractive interior atmosphere.

The arcade area, in which candies, pastry, and liquors are sold, serves as the entrance to the store proper. It has a ceiling height of 14 feet. To create the desired effect in this area, it is illuminated from recessed troffers, 40 inches in diameter, housing 500-watt silvered bowl lamps. The south wall of this area, lined with shelves and papered to the ceiling, is lighted with a wall-to-wall valance. Additional lighted display areas are provided by lighted shadow boxes recessed into the upper wall, lighted display cases, and adjustable downlights (200-watt PAR-46) recessed into the ceiling. General lighting provided by the large coffers is approximately 30 footcandles, while the supplementary downlights make available from 100 to 200 footcandles for highlighting special displays.

In the self-serve portion of the store, continuous rows of two-lamp 96T12 slimline lamp fixtures, interspaced with in-line filament downlights ,are mounted directly on the arched ceiling. The ceiling varies from 15 to 27 feet in height, and the decision to mount the lighting units on the ceiling was based on the knowledge that suitable telescopic maintenance equipment was available. The fluorescent system provides a general lighting level of 40 footcandles, and the filament spotlamps permit feature display illumination of well over 100 footcandles. Cross-louvers are installed on the fluorescent luminaires for customer comfort, but in order to maintain a high visible brightness from the street, longitudinal shielding is omitted.

Over the meat counter, recessed adjustable downlights housing 200-watt PS-30 filament lamps provide 70 footcandles. The ceiling is brightened by the use of a two-lamp fluorescent unit.

Colors play an important part in the interior design of this market. The arched roof girders are burgundy against a dead white ceiling, while the north curtain wall, south curtain wall, east wall, and west wall are respectively, forest green, vivid yellow, pea green, and chartreuse. The floor alternates mottled green and gray stripes. In the arcade, the ceiling is cinnamon brown, the wallpaper is predominantly tan, and the floor is mottled red and gray.

Engineers were A. Epstein and Sons, Chicago; data and photographs were furnished by S. Krivo of that firm. Illustrations are Hedrich-Blessing photographs.

The Zonal Method of Computing Coefficients of Utilization and Illumination on Room Surfaces

By J. R. JONES
JOHN J. NEIDHART

The data required for calculating coefficients of utilization are presented for areas having both 14 per cent and 30 per cent floor reflectances. Also presented are the tables and curves for calculating average illumination on wall and ceiling surfaces. These latter data are presented in Parts II and III respectively.

THE CONCEPT of the Zonal Method of calculating coefficients of utilization was introduced in an earlier paper.[1] At that time special effort was devoted to developing a system aimed at providing precise coefficients for high bay concentrating industrial luminaires. In Part I of this paper further data are provided for other luminaire types, for additional installation arrangements, and for a higher floor reflectance. In Part II and Part III data are provided for calculating the average illumination on, or brightness of, walls and ceilings.

PART I.—*Coefficients of Utilization for Calculating Illumination on the Work Plane*

The illumination on the work plane is comprised of lumens from two principal components:

1. Lumens directed downward (0° to 90°) by the luminaire that

   a. strike the work plane directly (without first being reflected from walls or ceiling). This sub-component is called the *Direct Ratio* and is expressed as a percentage (decimal) of the downward (0° to 90°) luminaire lumens.

   b. are reflected from the room surfaces to the work plane. This sub-component is called the *Downward Reflected Component* and also is expressed as a percentage (decimal) of the downward luminaire lumens.

   The total component (sum of a and b) is called the *Downward Utilization Factor.*

2. Lumens directed upward (90° to 180°) by the luminaire that are reflected by the upper walls and ceiling to the work plane. This is called the *Upward Utilization Factor* and is expressed as a percentage (decimal) of the upward luminaire lumens.

The coefficient of utilization (per cent of bare lamp lumens that reach the work plane) can be found from the following formula:

$$\text{Coefficient of Utilization} = (\text{Downward Utilization Factor}) \times \frac{0° \text{ to } 90° \text{ Luminaire Lumens}}{\text{Lamp Lumens per Luminaire}} + (\text{Upward Utilization Factor}) \times \frac{90° \text{ to } 180° \text{ Luminaire Lumens}}{\text{Lamp Lumens per Luminaire}}$$

Determination of Downward Utilization Factor

The Downward Utilization Factor is the sum of the direct ratio and the Downward Reflected Component.

Direct Ratio.—The Direct Ratio is found by multiplying the luminaire lumens in each 10-degree zone by the appropriate Zonal Multiplier as listed in Table I or Table II, and dividing the sum of the products for a given room index by the downward (0° to 90°) luminaire lumens. A Zonal Multiplier is the decimal percentage of the luminaire lumens in the indicated 10-degree zone that will strike the work plane directly in a room having the designated room index. The Zonal Multipliers listed in Table I are based on a spacing-to-mounting-height (above the work plane) ratio of 0.4; those in Table II on a spacing-to-mounting-height (above the work plane) ratio of 1.0. It may be noted that some of the individual Zonal Multipliers in Table I are considerably different from the corresponding ones in Table II. For this reason Table II yields somewhat higher Direct Ratios.

In calculating coefficients of utilization for a specific luminaire, the choice between Table I and Table II should be made on the basis of the spacing-to-mounting height ratios that will probably apply to the luminaire in actual use.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Sept. 8-12, 1952, Chicago, Ill.
AUTHORS: Westinghouse Electric Corp., Bloomfield, N. J. and Cleveland, Ohio, respectively.

TABLE I.—Zonal Multipliers* (0° to 90°) for 0.4 Spacing-to-Mounting-Height Ratio.

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	.72	.79	.81	.85	.88	.91	.92	.94	.95	.96
20-30	.57	.67	.73	.79	.83	.87	.89	.91	.93	.94
30-40	.34	.50	.56	.64	.69	.77	.82	.85	.88	.91
40-50	.16	.36	.49	.57	.64	.72	.78	.81	.86	.88
50-60	.03	.12	.28	.39	.48	.60	.67	.72	.78	.83
60-70	—	—	.05	.21	.31	.43	.52	.59	.69	.77
70-80	—	—	—	—	—	.11	.22	.32	.47	.60
80-90	—	—	—	—	—	—	—	—	.04	.14

*For a given room index the Direct Ratio is found by multiplying the lumens emitted by the luminaire in each 10° zone by the Zonal Multiplier for the respective zone, adding the products and dividing by the 0° to 90° luminaire lumens.

TABLE II.—Zonal Multipliers* (0° to 90°) for 1.0 Spacing-to-Mounting-Height Ratio.

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
20-30	.86	.90	.92	.94	.95	.96	.97	.97	.98	.98
30-40	.21	.40	.52	.61	.68	.76	.81	.84	.88	.90
40-50	.14	.32	.43	.53	.60	.70	.75	.79	.84	.87
50-60	0	.13	.27	.39	.48	.60	.67	.72	.80	.83
60-70	0	0	.02	.13	.24	.40	.51	.58	.68	.74
70-80	0	0	0	0	.01	.09	.20	.31	.46	.55
80-90	0	0	0	0	0	0	0	.01	.05	.10

*For a given room index the Direct Ratio is found by multiplying the lumens emitted by the luminaire in each 10° zone by the Zonal Multiplier for the respective zone, adding the products and dividing by the 0° to 90° luminaire lumens.

The authors believe that the following criteria present a fair basis for selecting the table of zonal multipliers:

1. Use Table I if the total output of the lamps most likely to be used in the luminaire is less than 8000 lumens, *or* if the recommended maximum spacing to mounting height (above floor) ratio is less than 0.8.

2. Use Table II if the total lamp lumens exceed 8000, *and* if the recommended maximum spacing to mounting height (above floor) ratio is 0.8 or greater.

Downward Reflected Component.—The Downward Reflected Component is the percentage of 0° to 90° luminaire lumens that reach the work plane after being reflected from the room surfaces. This component is dependent on the room surface reflectances as well as on the room shape and on the luminaire distribution. Downward Reflected Component is plotted against Direct Ratio for the common wall and ceiling reflectance combinations in Figs. 1 and 2. Fig. 1a and Fig. 2a apply to areas where the floor reflectance is 14 per cent, and Figs. 1b and 2b where the floor reflectance is 30 per cent.

There are four sets of curves (two for each floor reflectance) because for each room index there are two room shapes, one applicable to predominantly direct luminaires* and one applicable to predominantly indirect luminaires.** For example, a room 15 feet square with direct luminaires mounted 10 feet above the floor has exactly an "H" room index according to the I.E.S. formula for calculating room indices for predominantly direct luminaires. But a 15-foot square room in which predominantly indirect luminaires are mounted must have a ceiling height of 13.75 feet to have exactly an "H" room index according to the I.E.S. formula for semi-indirect and indirect luminaires. The differences between the data for the two types of mounting are great enough to change the final coefficient of utilization as much as 10 per cent.

In calculating coefficients of utilization the selection among the curves in Figs. 1a and 1b and 2a and 2b should be made on the basis of the following criteria:

1. Figs. 1a and 1b should be used for all luminaires that will be mounted on, in (recessed into), or near (within 12 inches of) the ceiling.

2. Figs. 2a or 2b should be used for all luminaires that will be suspended below the ceiling (12 inches or more).

3. Figs. 1a or 2a should be used unless the coefficients are to be specifically designated as applicable for areas having a floor reflectance of 30 per cent.

Determination of Upward Utilization Factor

The Upward Utilization Factor is the decimal percentage of upward luminaire lumens that are reflected to the work plane by the upper walls and ceiling. This factor is dependent on room shape, on room surface reflectances, and on the *Ceiling Ratio* (percentage of upward luminaire lumens that strike the ceiling directly). Since the Upward Utilization Factor is partly dependent on room shape, two sets of data are provided for each room index, one for suspended luminaires, the other for ceiling-mounted luminaires. The data for suspended luminaires are presented in Figs. 3a and 3b. Fig. 3a is for areas having a 14 per cent floor reflectance, Fig. 3b for areas having a 30 per cent floor reflectance. In these figures Upward Utilization Factor for each room index and each room surface reflectance combination is plotted against Ceiling Ratio. The Ceiling Ratio is obtained as outlined in the caption of Table III. The Zonal Multipliers in Table III are less dependent on the spacing-to-mounting-height ratio than those in Table I and Table II, and tables for two spacing-to-mounting-height ratios are not justified.

For luminaires that are ceiling-mounted, the Ceiling Ratio does not vary significantly and therefore it is possible to present the Upward Utilization Factors in tabular form. Table IVa applies to ceiling-mounted luminaires in areas having a 14

*Direct, semi-direct, general diffuse and direct-indirect luminaires.
**Semi-indirect and indirect luminaires.

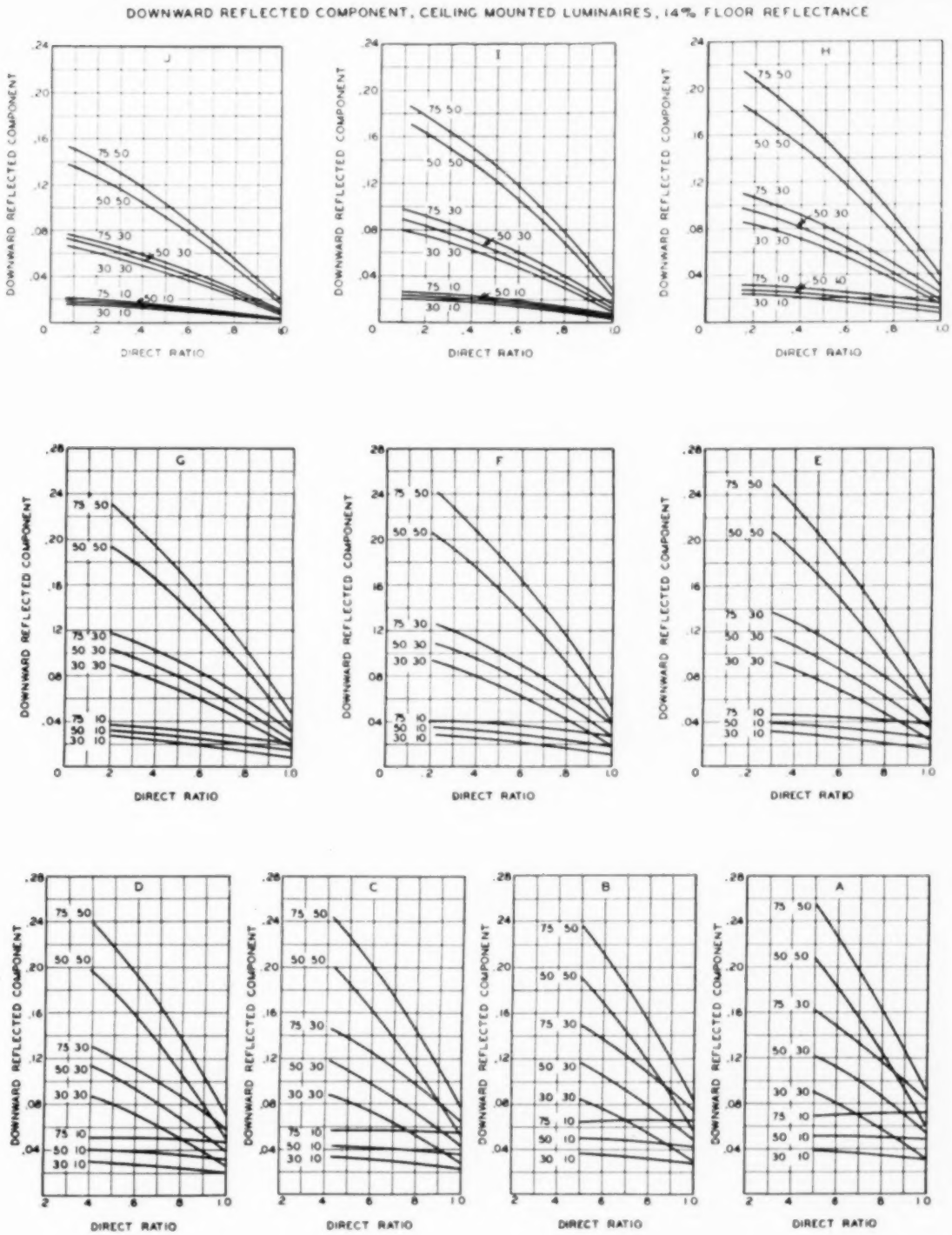


Figure 1a. Downward Reflected Component plotted against Direct Ratio for each room index. The figures accompanying each curve denote ceiling and wall reflectances.

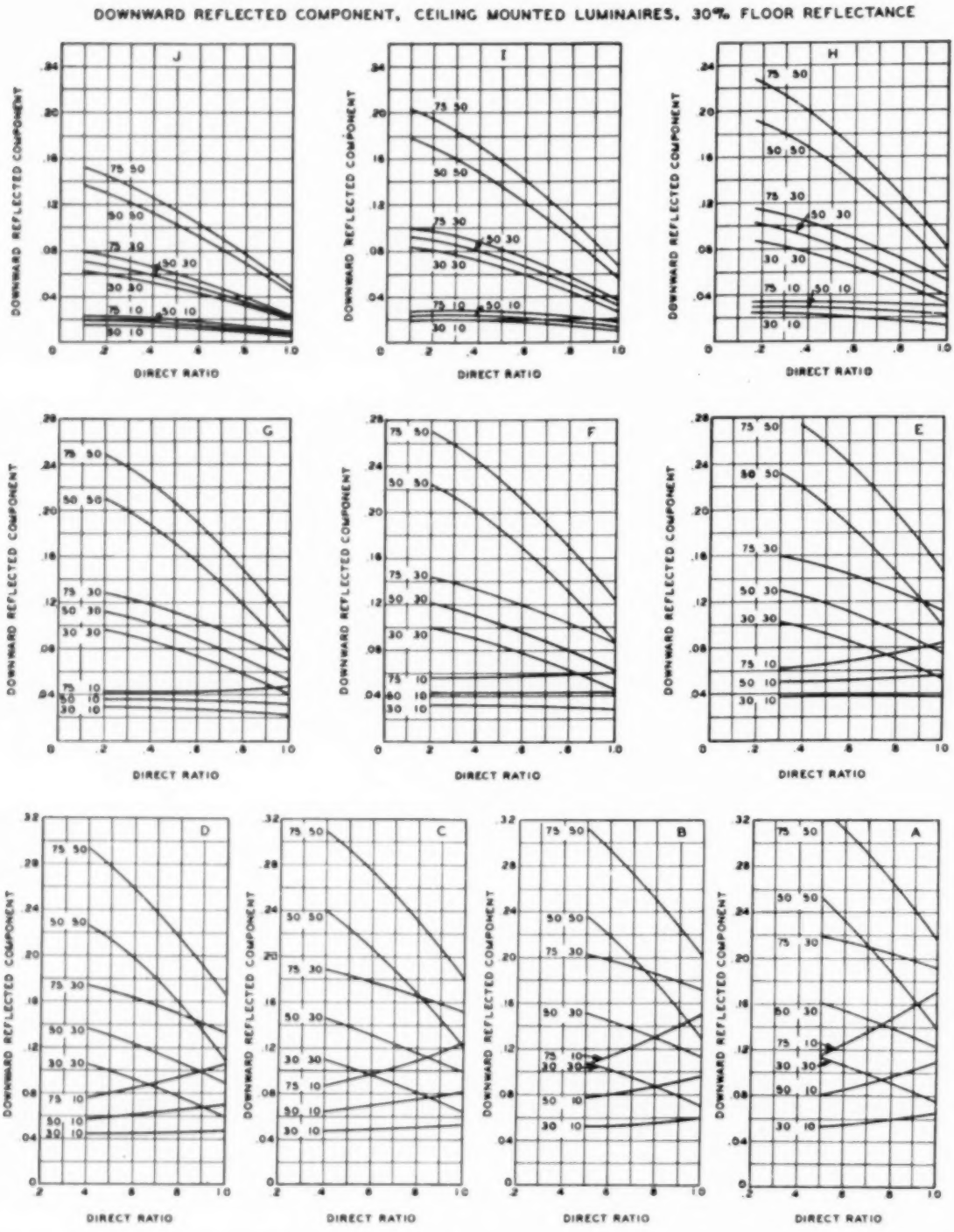


Figure 1b. Downward Reflected Component plotted against Direct Ratio for each room index. The figures accompanying each curve denote ceiling and wall reflectances.

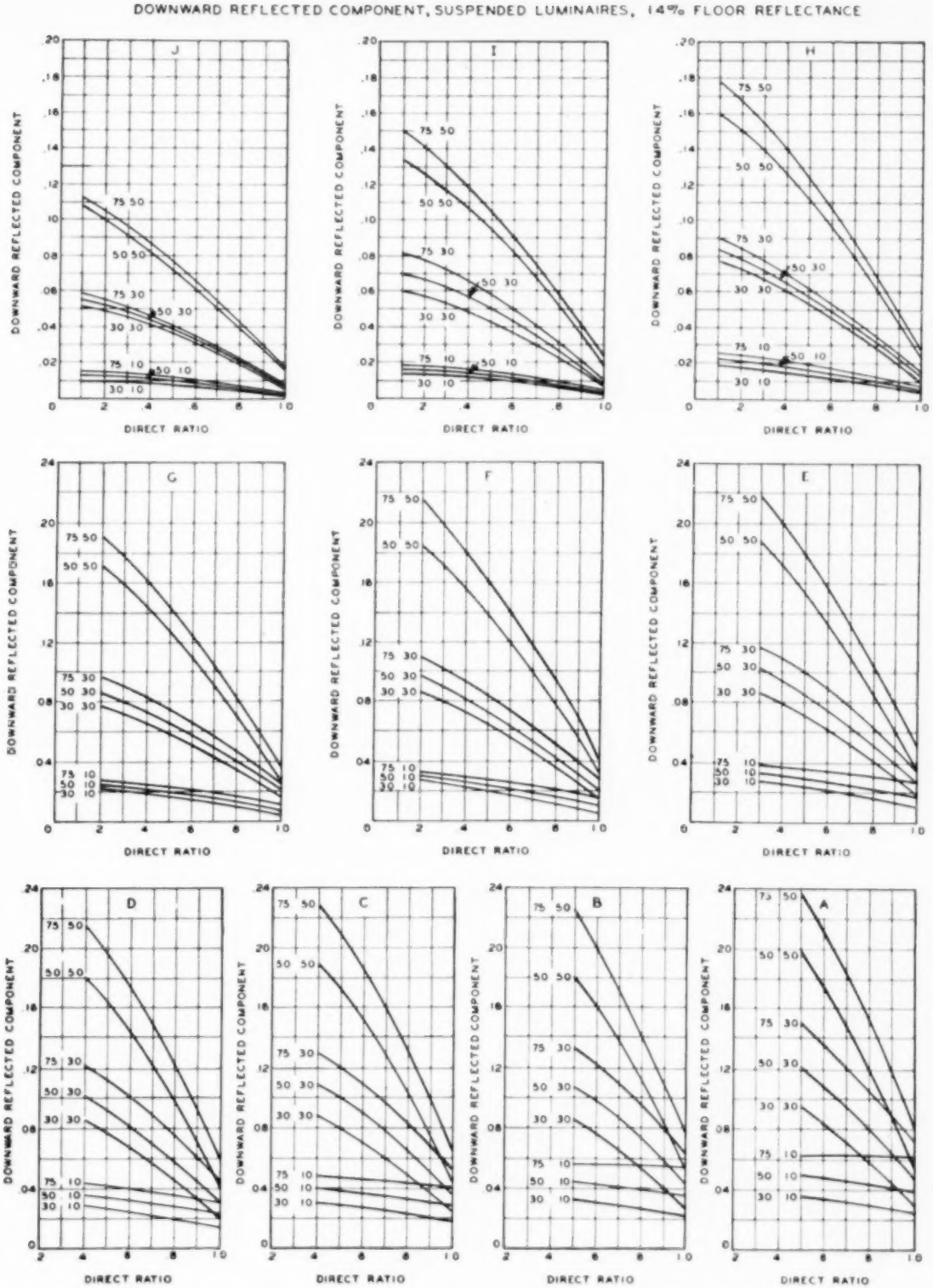


Figure 2a. Downward Reflected Component plotted against Direct Ratio for each room index. The figures accompanying each curve denote ceiling and wall reflectances.

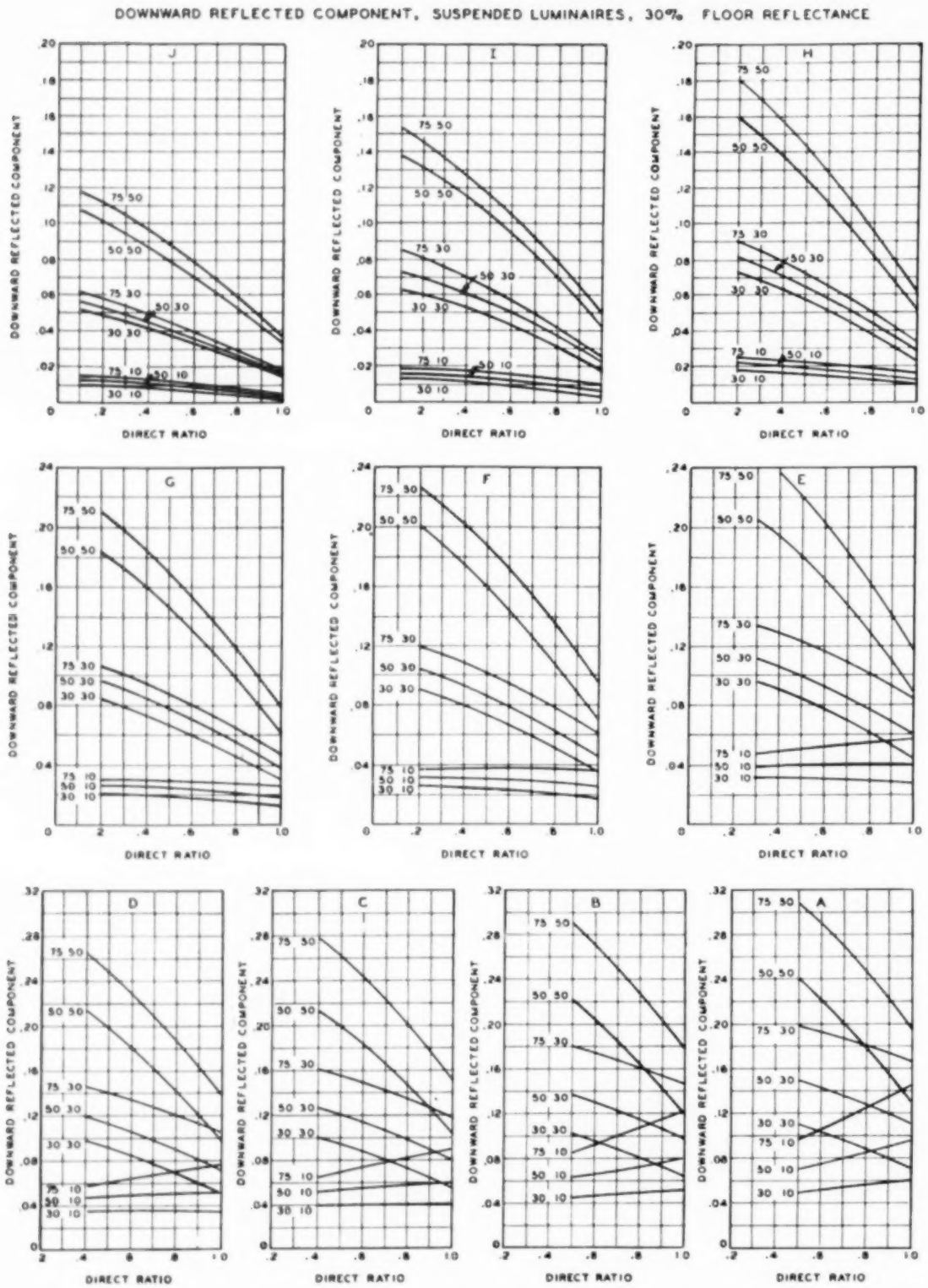


Figure 2b. Downward Reflected Component plotted against Direct Ratio for each room index. The figures accompanying each curve denote ceiling and wall reflectances.

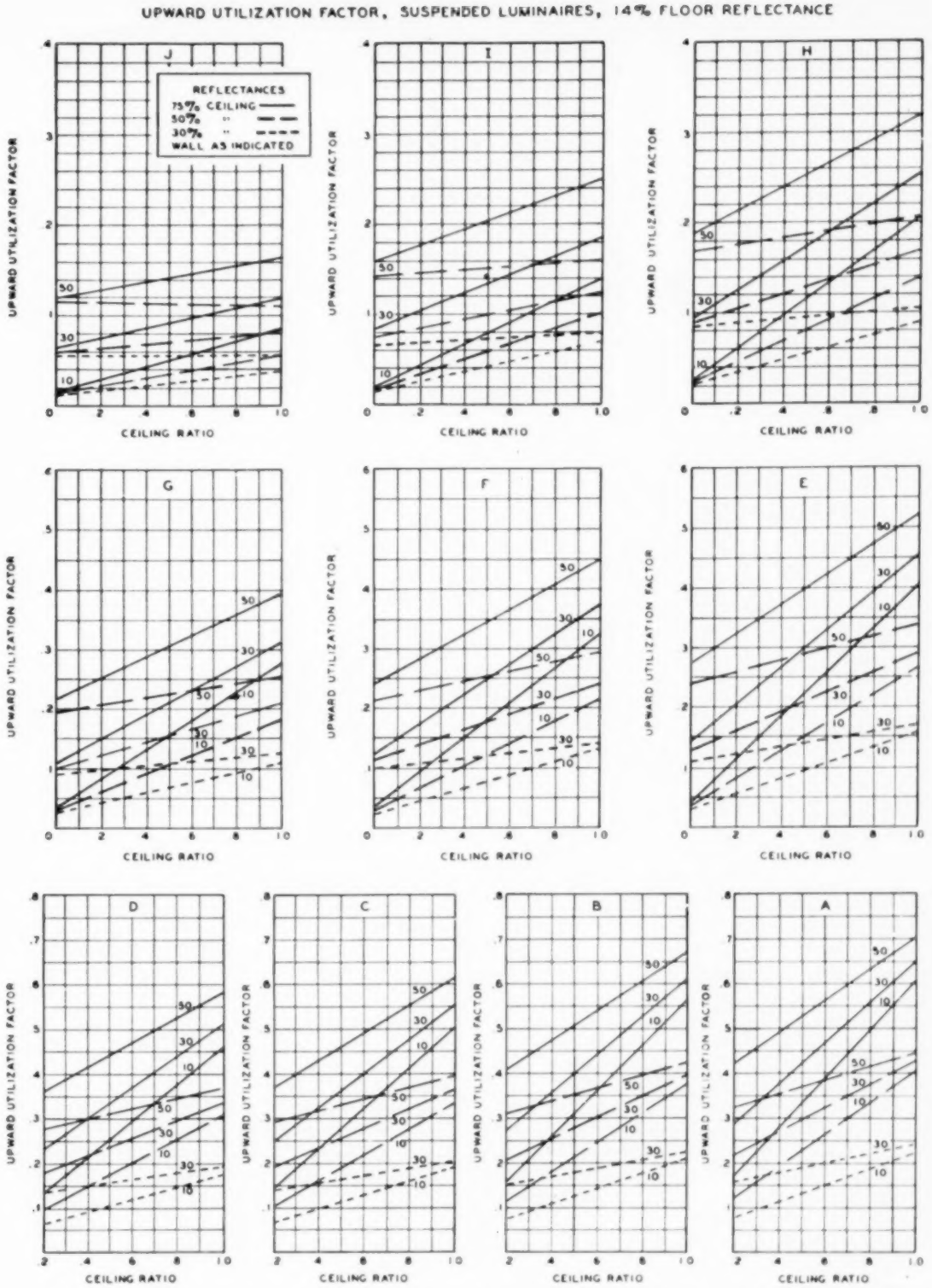


Figure 3a. Upward Utilization Factor plotted against Ceiling Ratio for each room index. Curves apply to suspended luminaires; for data on ceiling mounted luminaires see Tables IVa and IVb.

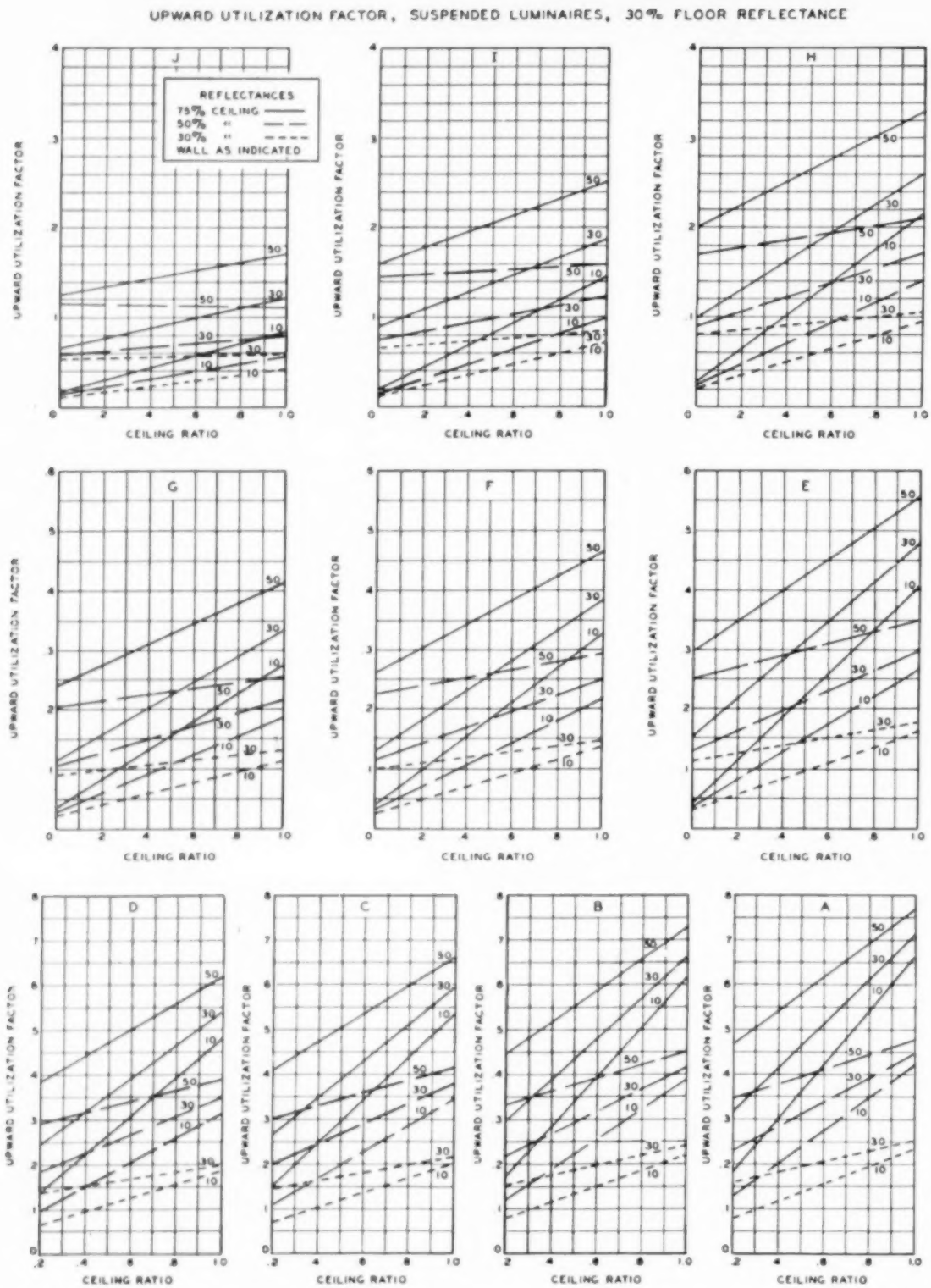


Figure 3b. Upward Utilization Factor plotted against Ceiling Ratio for each room index. Curves apply to suspended luminaires; for data on ceiling mounted luminaires see Tables IVa and IVb.

TABLE III.—Zonal Multipliers* (90° to 180°).

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
90-100	—	—	—	—	—	.04	.14	.22	.33	.40
100-110	—	—	.10	.22	.32	.47	.60	.67	.76	.81
110-120	.20	.34	.43	.52	.59	.69	.77	.82	.89	.93
120-130	.37	.50	.60	.67	.72	.78	.83	.88	.91	.94
130-140	.56	.66	.72	.78	.81	.86	.88	.91	.94	.95
140-150	.63	.71	.77	.82	.85	.88	.91	.94	.96	.97
150-180	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

*For a given room index the Ceiling Ratio is found by multiplying the lumens emitted by the luminaire in each zone by the Zonal Multiplier for the respective zone, adding the products, and dividing by the 90° to 180° luminaire lumens.

per cent floor reflectance, Table IVb to areas having a 30 percent floor reflectance.

Recommended use of Upward Utilization Factor data:

1. Use Curves in Figs. 3a or 3b for luminaires designed for suspension mounting.

2. Use Tables IVa or IVb for ceiling mounted luminaires that direct some light upward.

3. Fig. 3a or Table IVa apply if the floor reflectance is 14 per cent, and should be used unless the coefficients are to be designated as applicable to areas having 30 per cent floor reflectance.

PART II.—*Wall Illumination and Wall Brightness*

A knowledge of the brightness to be produced on room surfaces by a given lighting layout is useful in designing comfortable lighting. Also, the illumination on wall surfaces is a good indication (though not a direct measure) of the illumination on vertical surfaces within the room. The following data are presented to permit predetermination of this illumination. If the Direct Ratio and Ceiling Ratio are known (from Part I), only three additions and three multiplications, in addition to the solution of a simple footcandle formula, are required to compute wall illumination.

The illumination on the wall consists of lumens from two principal components:

1. Lumens directed downward (0° to 90°) by the luminaire that

   a. strike the wall directly (without being first reflected by the room surfaces). When expressed as a percentage (decimal) of the downward luminaire lumens this sub-component is the *Downward Wall Ratio.*

   b. are reflected to the walls. When expressed as a percentage (decimal) of the downward luminaire lumens, this sub-component is the *Downward Wall Reflected Component.*

The total component (sum of a and b) is the *Downward Wall Utilization Factor.*

2. Lumens directed upward (90° to 180°) by the luminaire that

   a. strike the wall directly. When expressed as a percentage (decimal) of the upward luminaire lumens this sub-component is the *Upward Wall Ratio.*

   b. are reflected to the walls. When expressed as a percentage (decimal) of the upward luminaire lumens this sub-component is the *Upward Wall Reflected Component.*

The total component (sum of a and b) is called the *Upward Wall Utilization Factor.*

TABLE IVa.—Upward Utilization Factors
Ceiling-Mounted Luminaires
14 Per Cent Floor Reflectance.

Ceiling	75%			50%			30%	
Walls	50%	30%	10%	50%	30%	10%	30%	10%
Room Index	Upward Utilization Factors							
J	.245	.180	.125	.160	.120	.080	.075	.050
I	.325	.260	.210	.220	.175	.135	.100	.080
H	.395	.325	.275	.265	.220	.180	.125	.100
G	.465	.395	.340	.310	.260	.225	.140	.120
F	.515	.455	.400	.345	.295	.265	.155	.135
E	.580	.530	.485	.375	.340	.315	.175	.155
D	.625	.570	.530	.400	.370	.345	.190	.170
C	.650	.610	.560	.415	.390	.370	.205	.185
B	.690	.660	.610	.440	.420	.390	.220	.200
A	.720	.690	.650	.450	.435	.420	.230	.210

TABLE IVb.—Upward Utilization Factors
Ceiling-Mounted Luminaires
30 Per Cent Floor Reflectance.

J	.250	.185	.130	.165	.125	.085	.085	.060
I	.335	.265	.215	.225	.180	.140	.110	.090
H	.410	.335	.280	.270	.225	.185	.135	.115
G	.490	.415	.350	.320	.270	.235	.150	.130
F	.550	.470	.410	.350	.300	.270	.165	.145
E	.630	.560	.500	.390	.350	.320	.190	.170
D	.680	.615	.565	.420	.385	.355	.205	.190
C	.715	.660	.610	.445	.410	.385	.225	.205
B	.773	.720	.680	.475	.445	.425	.240	.220
A	.810	.760	.720	.490	.470	.450	.250	.230

These Upward Utilization Factors are based on the following Ceiling Ratios: J—0.84; I—0.88; H—0.90; G—0.92; F—0.94; E—0.96; D—0.98; C—0.99; B—0.99; A—1.0

The average illumination on the wall is obtained from the following formula:

$$\text{Footcandles} = \frac{\text{Lumens per Luminaire} \times \text{Number of Luminaires} \times \text{Wall Coefficient of Utilization} \times \text{Maintenance Factor}}{\text{Total Wall Area}}$$

It will be noted that this formula is similar to the familiar one used for calculating illumination on the work plane, differing only in the Wall Area and the Wall Coefficient of Utilization terms. The latter term is determined from the following formula:

$$\text{Wall Coefficient of Utilization} = \text{Downward Wall Utilization Factor} \times \frac{0° \text{ to } 90° \text{ Luminaire Lumens}}{\text{Lamp Lumens per Luminaire}} + \text{Upward Wall Utilization Factor} \times \frac{90° \text{ to } 180° \text{ Luminaire Lumens}}{\text{Lamp Lumens per Luminaire}}$$

If the luminaire is totally direct only the first term is applicable; if totally indirect only the second term is applicable.

Determination of Downward Wall Utilization Factor

The Downward Wall Utilization Factor is the sum of the Downward Wall Ratio and the Downward Wall Reflected Component.

Downward Wall Ratio.—The Downward Wall Ratio sub-component is plotted against Direct Ratio in Fig. 4. This curve is applicable to all room indices and all room surface reflectances for both ceiling-mounted and suspended luminaires.

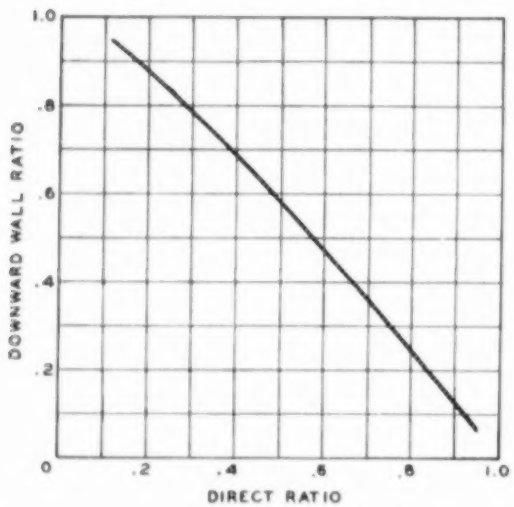


Figure 4. Downward Wall Ratio plotted against Direct Ratio. This curve applies to all room surface reflectances, and all room indices for both ceiling-mounted and suspended luminaires.

Downward Wall Reflected Component.—The Downward Wall Reflected Component may be obtained from Figs 5a or 5b or Figs. 6a or 6b. Figs. 5a and 5b are for ceiling-mounted luminaires, Figs. 6a and 6b for suspended luminaires. Figs. 5a and 6a are for areas having a 14 per cent floor reflectance, and Figs. 5b and 6b for areas having a 30 per cent floor reflectance.

Determination of Upward Wall Utilization Factor

The Upward Wall Utilization Factor is the percentage of upward luminaire lumens that ultimately strike the wall. This is the sum of the Upward Wall Ratio and the Upward Wall Reflected Component. The method of obtaining the Upward Wall Utilization Factor differs for suspended luminaires and ceiling-mounted luminaires.

TABLE Va.—Upward Wall Utilization Factors
Ceiling-Mounted Luminaires
14 Per Cent Floor Reflectance.

Ceiling	75%			50%			30%	
Walls	50%	30%	10%	50%	30%	10%	30%	10%
Room Index	Upward Wall Utilization Factors							
J	1.10	.84	.69	.77	.61	.50	.42	.35
I	.99	.78	.65	.69	.56	.46	.38	.32
H	.89	.72	.61	.61	.50	.43	.34	.29
G	.78	.66	.56	.53	.45	.39	.30	.26
F	.68	.60	.51	.46	.40	.35	.26	.23
E	.54	.49	.43	.36	.32	.28	.21	.18
D	.44	.41	.36	.29	.26	.24	.17	.15
C	.38	.35	.32	.25	.23	.20	.14	.12
B	.29	.27	.25	.19	.17	.15	.11	.10
A	.23	.22	.21	.15	.14	.13	.08	.07

TABLE Vb.—Upward Wall Utilization Factors
Ceiling-Mounted Luminaires
30 Per Cent Floor Reflectance.

J	1.16	.89	.73	.82	.65	.52	.45	.36
I	1.06	.84	.69	.74	.59	.48	.40	.34
H	.97	.78	.65	.67	.54	.45	.36	.31
G	.86	.72	.60	.59	.49	.41	.32	.27
F	.77	.65	.56	.51	.44	.37	.28	.24
E	.63	.55	.48	.41	.36	.31	.22	.20
D	.53	.46	.41	.33	.30	.27	.18	.16
C	.46	.41	.36	.28	.26	.23	.15	.14
B	.36	.33	.30	.22	.20	.18	.12	.11
A	.29	.27	.25	.18	.16	.15	.10	.09

These Upward Wall Utilization Factors are based on the following Ceiling Ratios: J—0.84; I—0.99; H—0.90; G—0.92; F—0.94; E—0.96; D—0.98; C—0.99; B—0.99; A—1.0.

Suspended Luminaires

Upward Wall Ratio.—All the upward (90° to 180°) luminaire lumens must strike directly either the upper walls or the ceiling. The per cent (decimal) of these lumens that strike the ceiling is the Ceiling Ratio. (See Table III, Part I.) The per cent (decimal) that strike the upper walls is the Upward Wall Ratio. Obviously the Ceiling Ratio plus the Upward Wall Ratio is equal to 1.0. Therefore the Upward Wall Ratio is equal to 1.0 minus the Ceiling Ratio.

Upward Wall Reflected Component.—The Upward Wall Reflected Component is plotted against Upward Wall Ratio in Figs. 7a and 7b.

Ceiling-Mounted Luminaires

The Ceiling Ratio, for a given room index, is approximately the same for all ceiling-mounted luminaires. Therefore it is possible to present the sum of Upward Wall Ratio and Upward Wall Reflected Component in tabular form. These data (Upward Wall Utilization Factors) are presented in Tables Va and Vb. Table Va is for areas having a 14 per cent floor reflectance, Vb for areas having a 30 per cent floor reflectance.

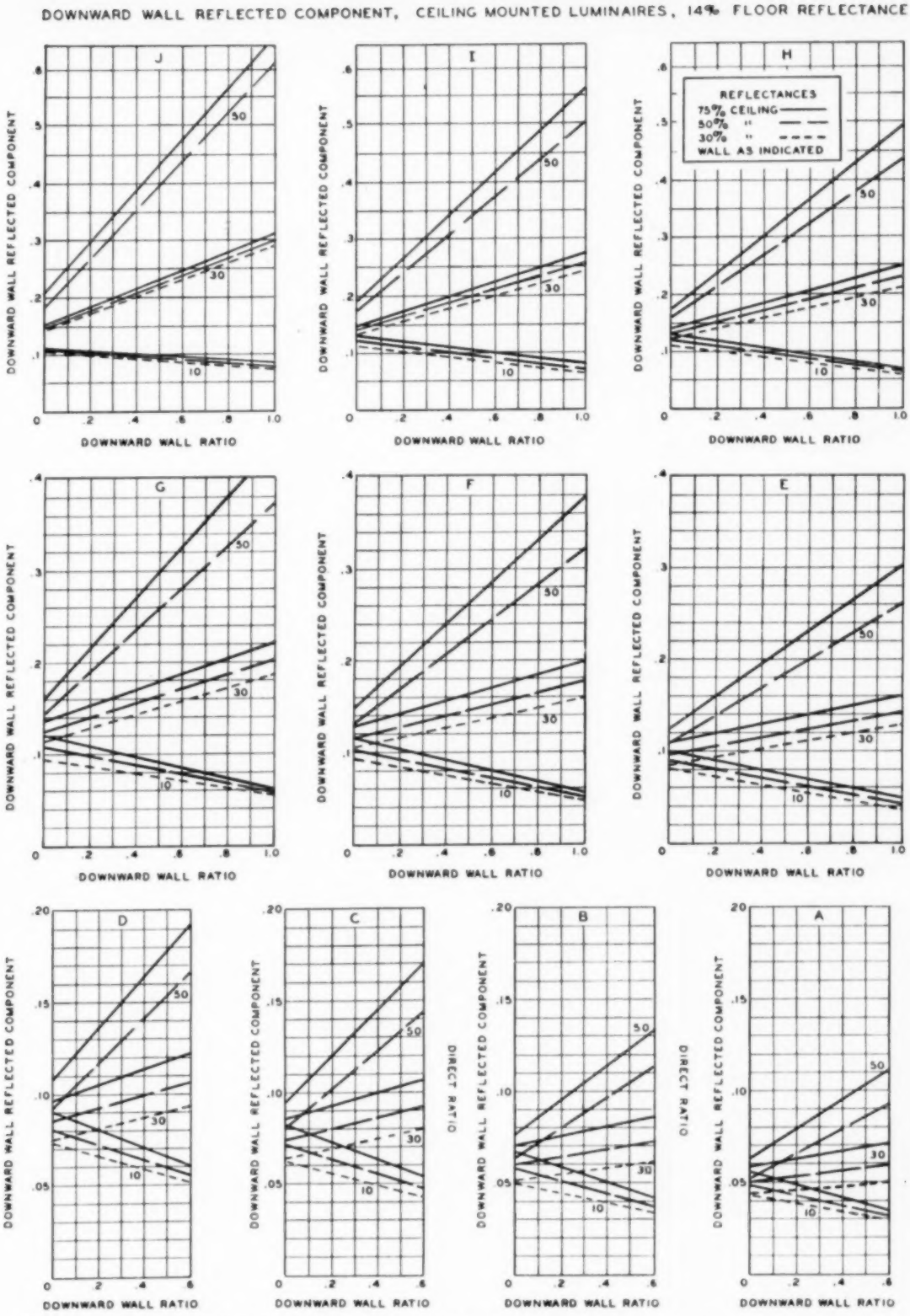


Figure 5a. Downward Wall Reflected Component plotted against Downward Wall Ratio for each room index.

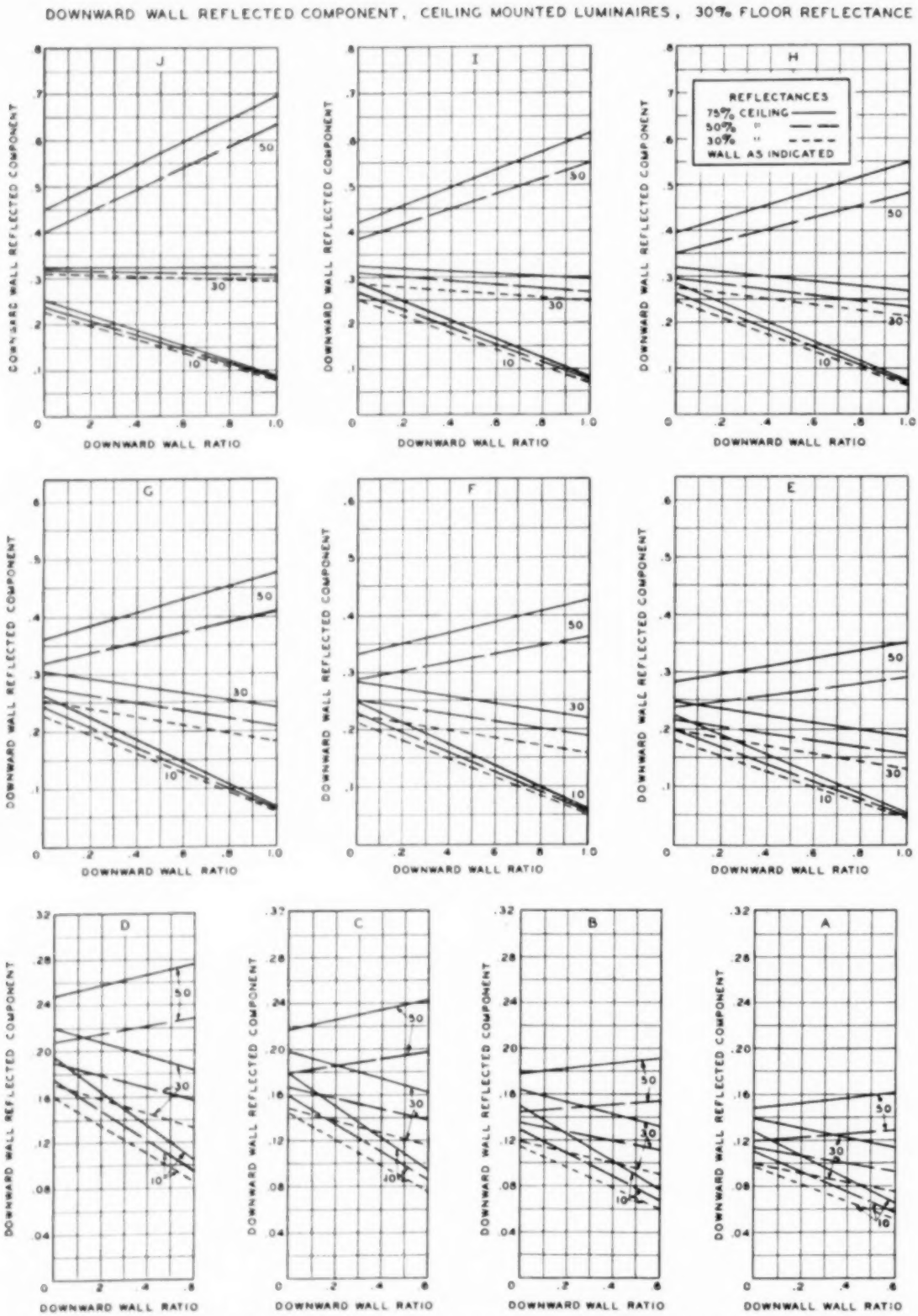


Figure 5b. Downward Wall Reflected Component plotted against Downward Wall Ratio for each room index.

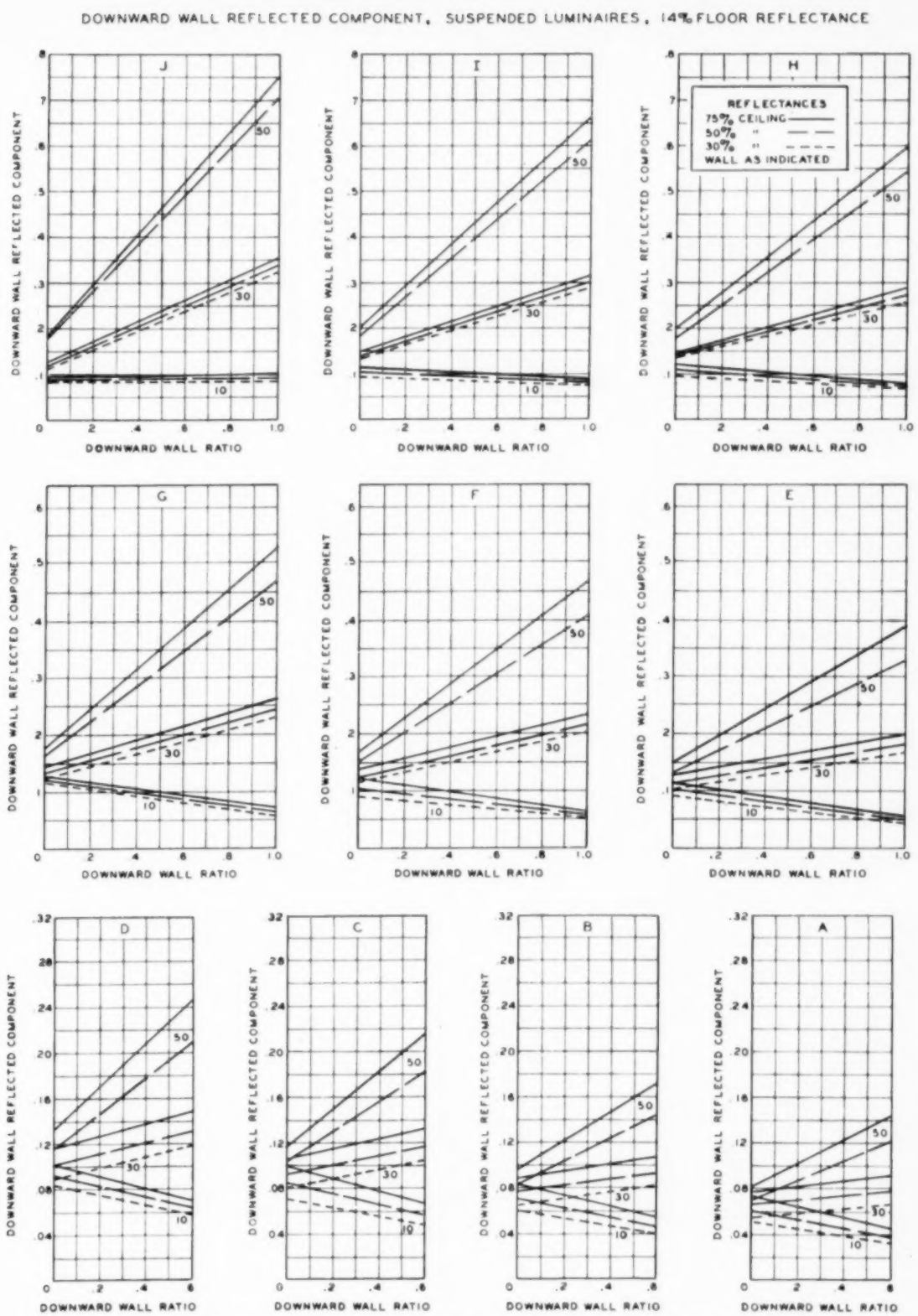


Figure 6a. Downward Wall Reflected Component plotted against Downward Wall Ratio for each room index.

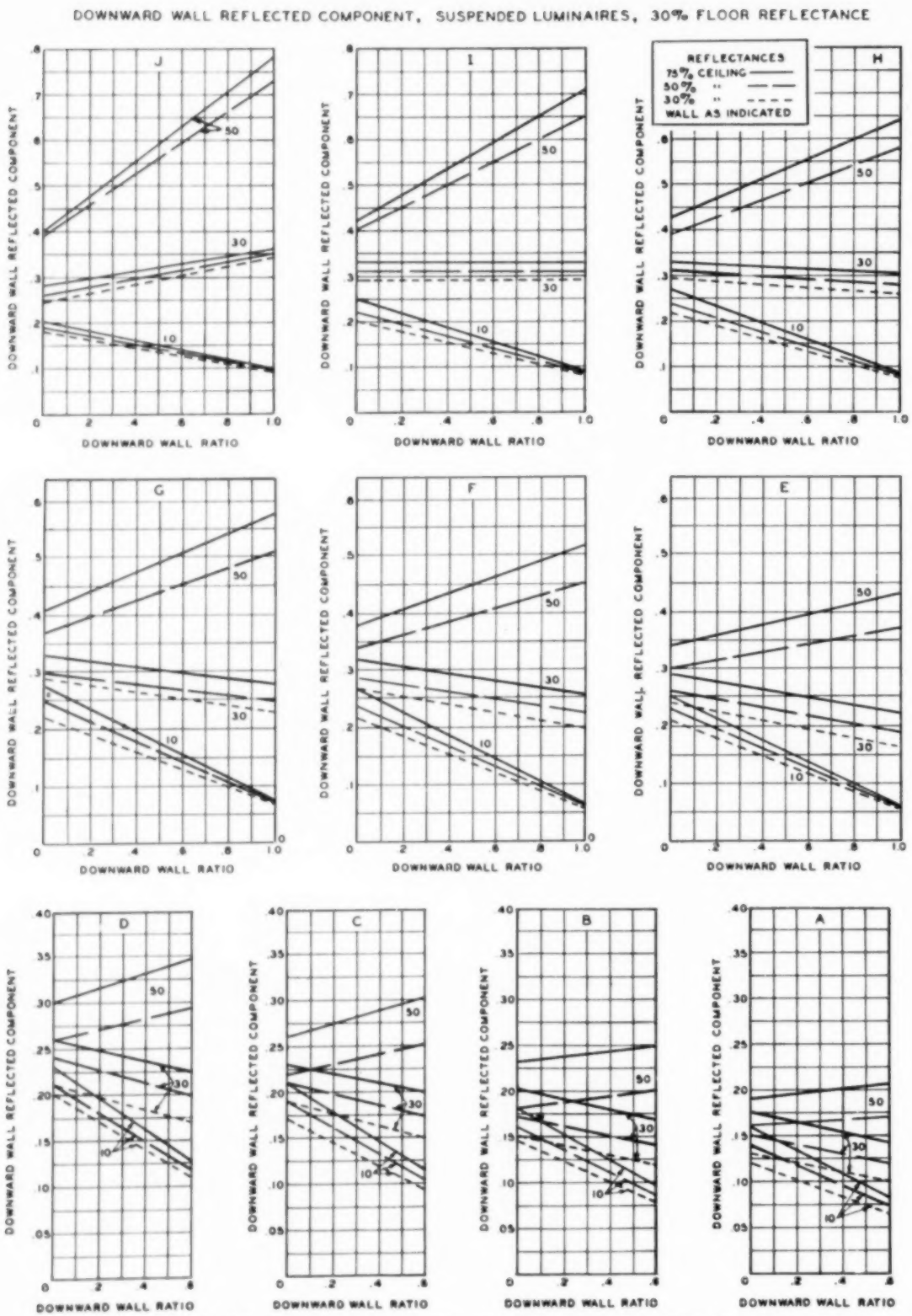


Figure 6b. Downward Wall Reflected Component plotted against Downward Wall Ratio for each room index.

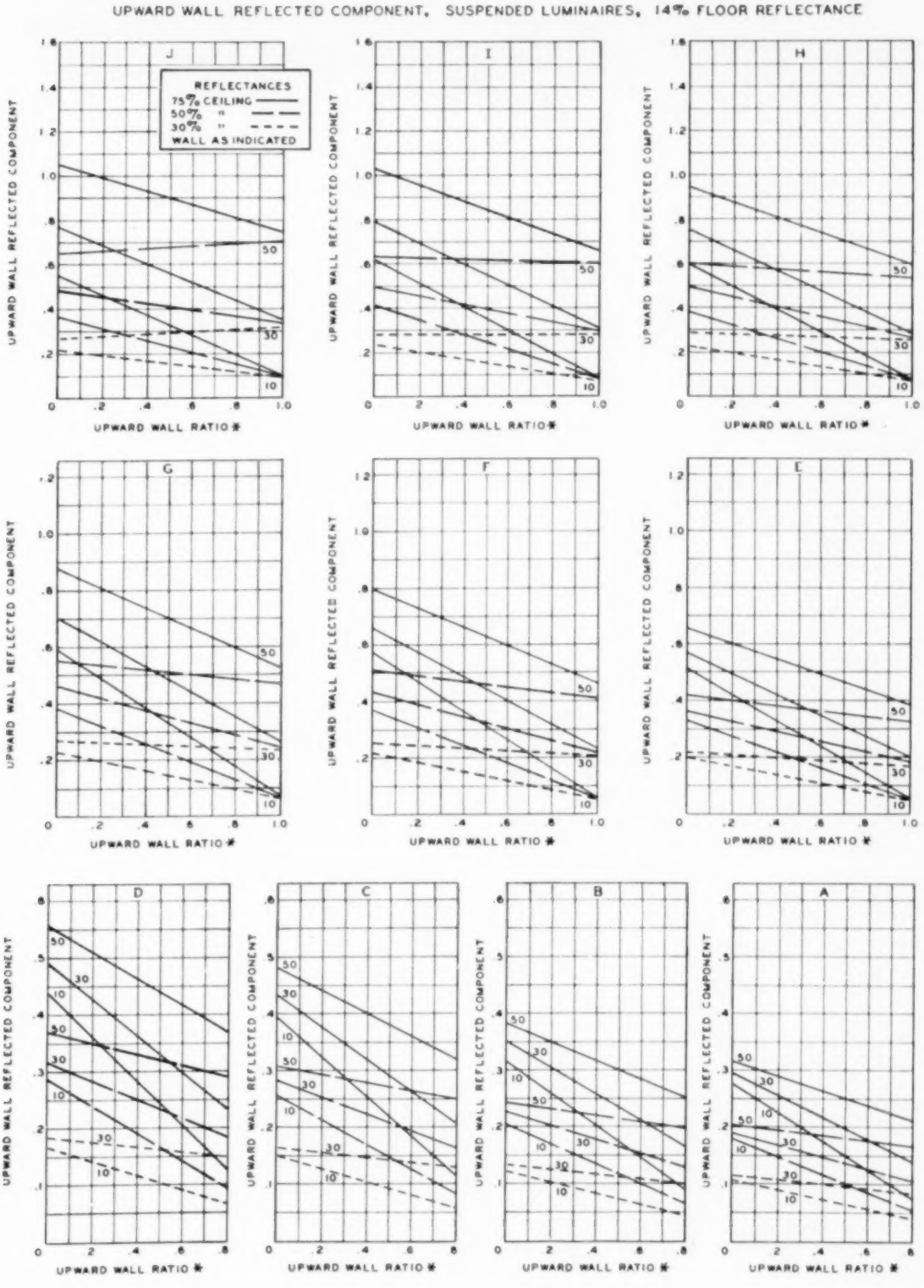
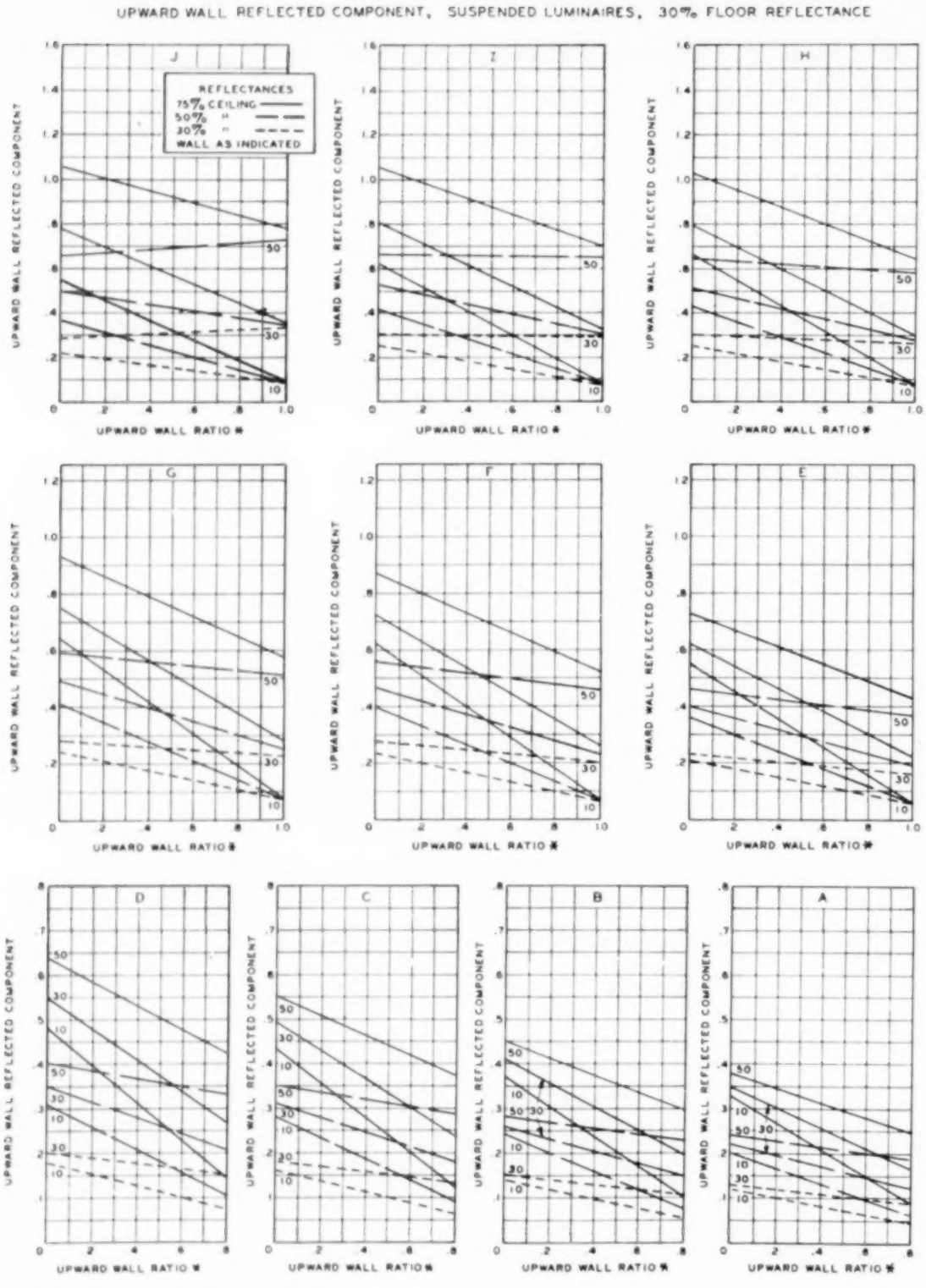


Figure 7a. Upward Wall Reflected Component plotted against Upward Wall Ratio for each room index. Curves apply to suspended luminaires; for data on ceiling-mounted luminaires see Tables Va and Vb. Ceiling Ratio is obtained as outlined in caption of Table III.



* UPWARD WALL RATIO = 1.0 MINUS CEILING RATIO

Figure 7b. Upward Wall Reflected Component plotted against Upward Wall Ratio for each room index. Curves apply to suspended luminaires; for data on ceiling-mounted luminaires see Tables Va and Vb. Ceiling Ratio is obtained as outlined in caption of Table III.

PART III.—*Ceiling Illumination and Ceiling Brightness*

Ceiling brightness is another of the criteria used to evaluate the comfort of a lighting installation.

The data that follow enable one to predict the illumination on the ceiling with but two multiplications and two additions, provided the Direct Ratio and Ceiling Ratio are known (from Part I).

The average illumination on the ceiling consists of lumens from two principal components:

1. Lumens directed upward (90° to 180°) by the luminaire that

   a. Strike the ceiling directly (without first being reflected). This sub-component is expressed as a percentage (decimal) of the upward luminaire lumens and is called the *Ceiling Ratio.*

   b. are reflected to the ceiling. This sub-component is also expressed as a percentage (decimal) of the upward luminaire lumens and is called the *Upward Ceiling Reflected Component.*

The sum of the Ceiling Ratio and the Upward Ceiling Reflected Component is the *Upward Ceiling Utilization Factor.*

2. Lumens directed downward (0° to 90°) by the luminaire that are reflected to the ceiling. This component is expressed as a percentage (decimal) of the downward luminaire lumens, and is called the *Downward Ceiling Utilization Factor.*

The illumination on the ceiling may be determined from the following formula:

$$\text{Footcandles} = \frac{\text{Lumens per Luminaire} \times \text{Number of Luminaires} \times \text{Ceiling Coefficient of Utilization} \times \text{Maintenance Factor}}{\text{Area of Ceiling}}$$

Note that this formula, also, is essentially the same as the familiar one used in calculating illumination on the work plane.

The Ceiling Coefficient of Utilization is determined as follows:

$$\begin{aligned}\text{Ceiling Coefficient of Utilization} = {} & \left(\begin{matrix}\text{Upward Ceiling} \\ \text{Utilization Factor}\end{matrix}\right) \times \frac{90^\circ \text{ to } 180^\circ \text{ Luminaire Lumens}}{\text{Lamp Lumens per Luminaire}} \\ & + \left(\begin{matrix}\text{Downward Ceiling} \\ \text{Utilization Factor}\end{matrix}\right) \times \frac{0^\circ \text{ to } 90^\circ \text{ Luminaire Lumens}}{\text{Lamp Lumens per Luminaire}}\end{aligned}$$

Determination of Upward Ceiling Utilization Factor

The Upward Ceiling Utilization Factor is the sum of the Ceiling Ratio and the Upward Ceiling Reflected Component. Data have been provided only for suspended luminaires. Upward Ceiling Utilization Factor Tables could be provided for use in determining the average ceiling illumination produced by the upward component of ceiling-mounted luminaires, but the illumination would be so spotty that an average value would be of very little use.

Ceiling Ratio.—The Ceiling Ratio is determined from Table III as outlined in Part I.

Upward Ceiling Reflected Component.—The Upward Ceiling Reflected Component is plotted against Ceiling Ratio in Figs. 8a and 8b (8a is for 14 per cent and 8b for 30 per cent floor reflectances).

Determination of Downward Ceiling Utilization Factor

The Downward Ceiling Utilization Factor is plotted against Direct Ratio in Figs. 9a and 9b and Figs. 10a and 10b. Figs. 9a and 9b are for those installations where the luminaires are suspended well below the ceiling. Fig. 9a applies if the floor reflectance is 14 per cent, Fig. 9b if the floor reflectance is 30 per cent.

Figs. 10a and 10b are for those applications where the luminaires are mounted near or recessed into the ceiling. Fig. 10a is for 14 per cent, Fig. 10b for 30 per cent floor reflectance. Figs. 10a and 10b will normally be used only for totally direct luminaires.

Conclusion

The data for the reflected component curves and utilization factor curves have been taken from the Interflectance Tables.[2] These curves and tables have been expressed in the terms of, and are for use in, the Lumen Method.[3]

The authors do not expect that equipment manufacturers will wish to publish six coefficient of utilization tables (for two floor reflectances for the work plane, walls, and ceiling). However, the data most likely to be needed can be provided by adding four columns to the present table of coefficients: two columns for work plane coefficients for areas having a 30 per cent floor reflectance, 75 per cent ceiling reflectance, and 50 per cent and 30 per cent wall reflectances, and the Direct Ratios and the Ceiling Ratios in the remaining two columns. Publication of these two ratios for each room index makes it convenient for the illuminating engineer to calculate the illumination on, or brightness of, the walls and ceiling in a specific area. In making these calculations the engineer is cautioned to judge carefully the expected room surface reflectances

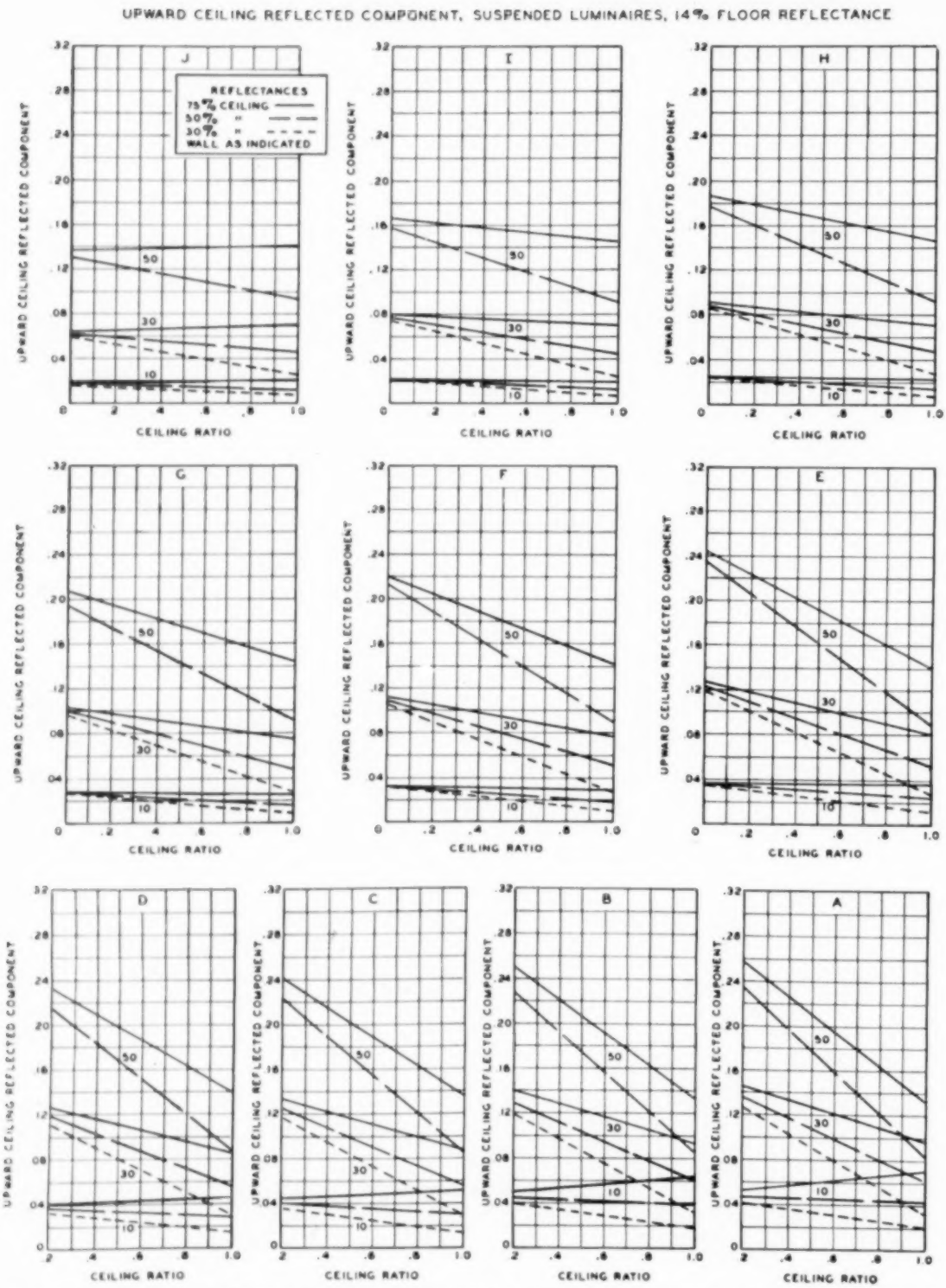


Figure 8a. Upward Ceiling Reflected Component plotted against Ceiling Ratio for each room index. Curves apply to suspended luminaires.

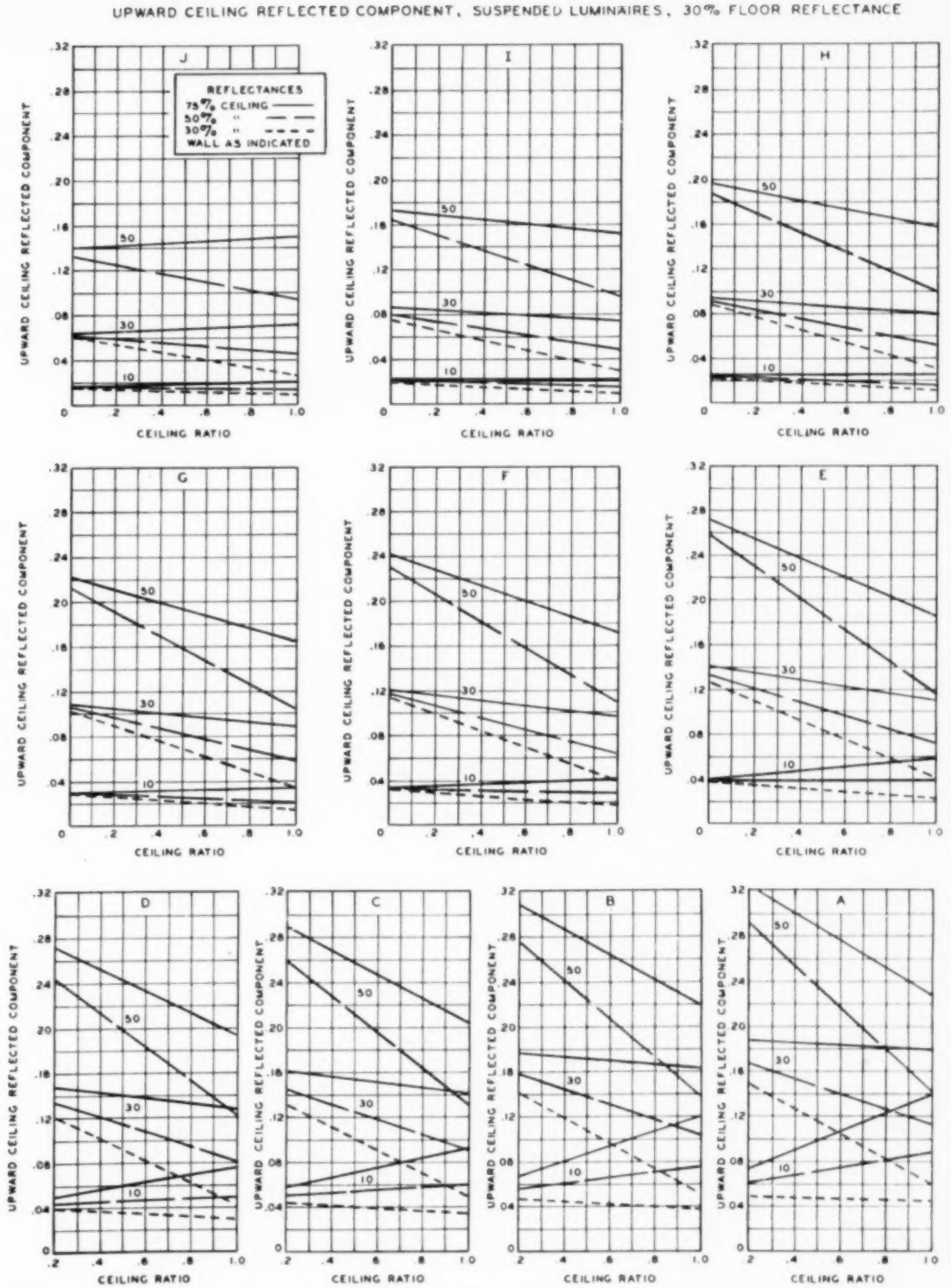


Figure 8b. Upward Ceiling Reflected Component plotted against Ceiling Ratio for each room index. Curves apply to suspended luminaires.

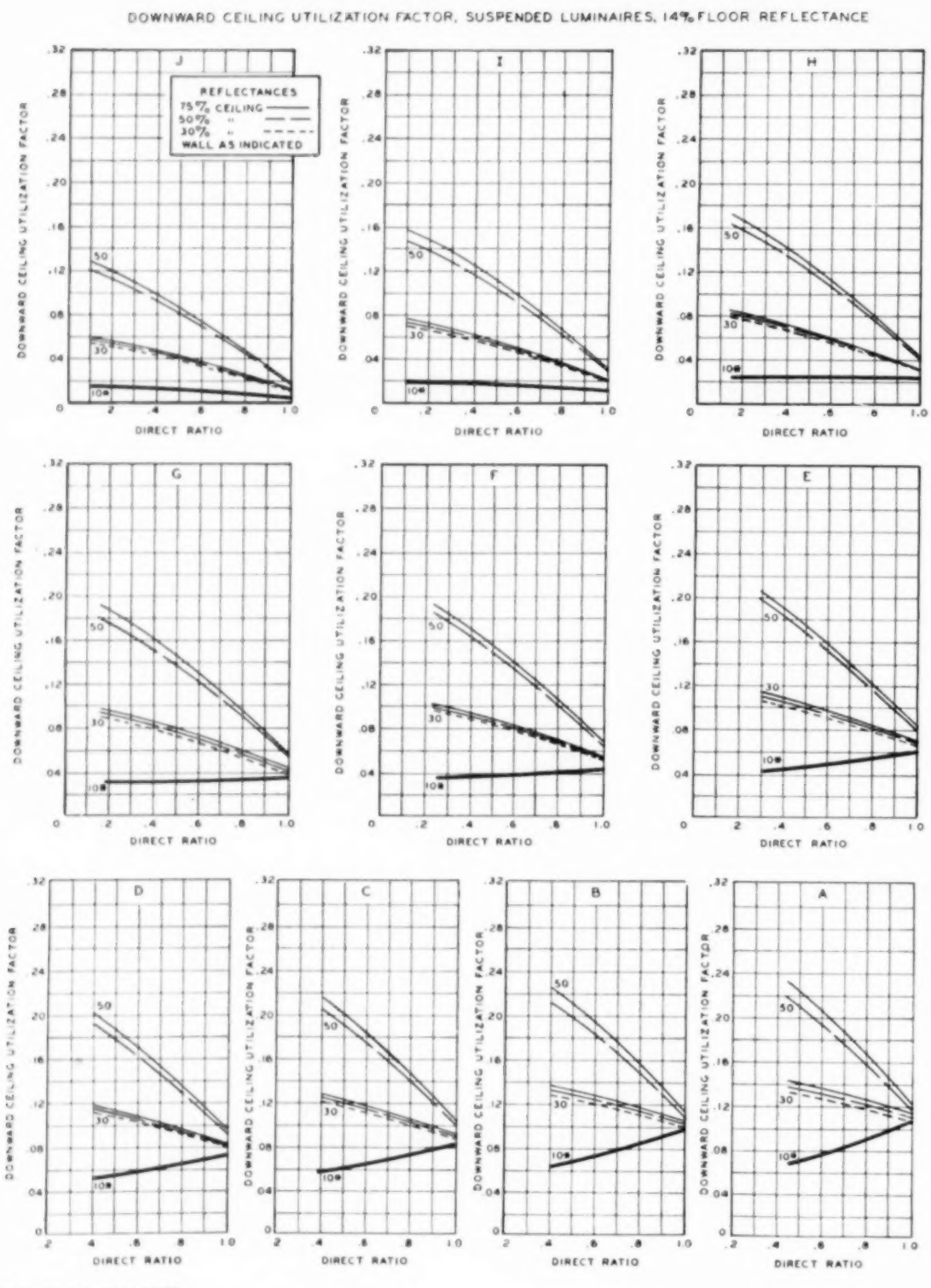


Figure 9a. Downward Ceiling Utilization Factor plotted against Direct Ratio for each room index.

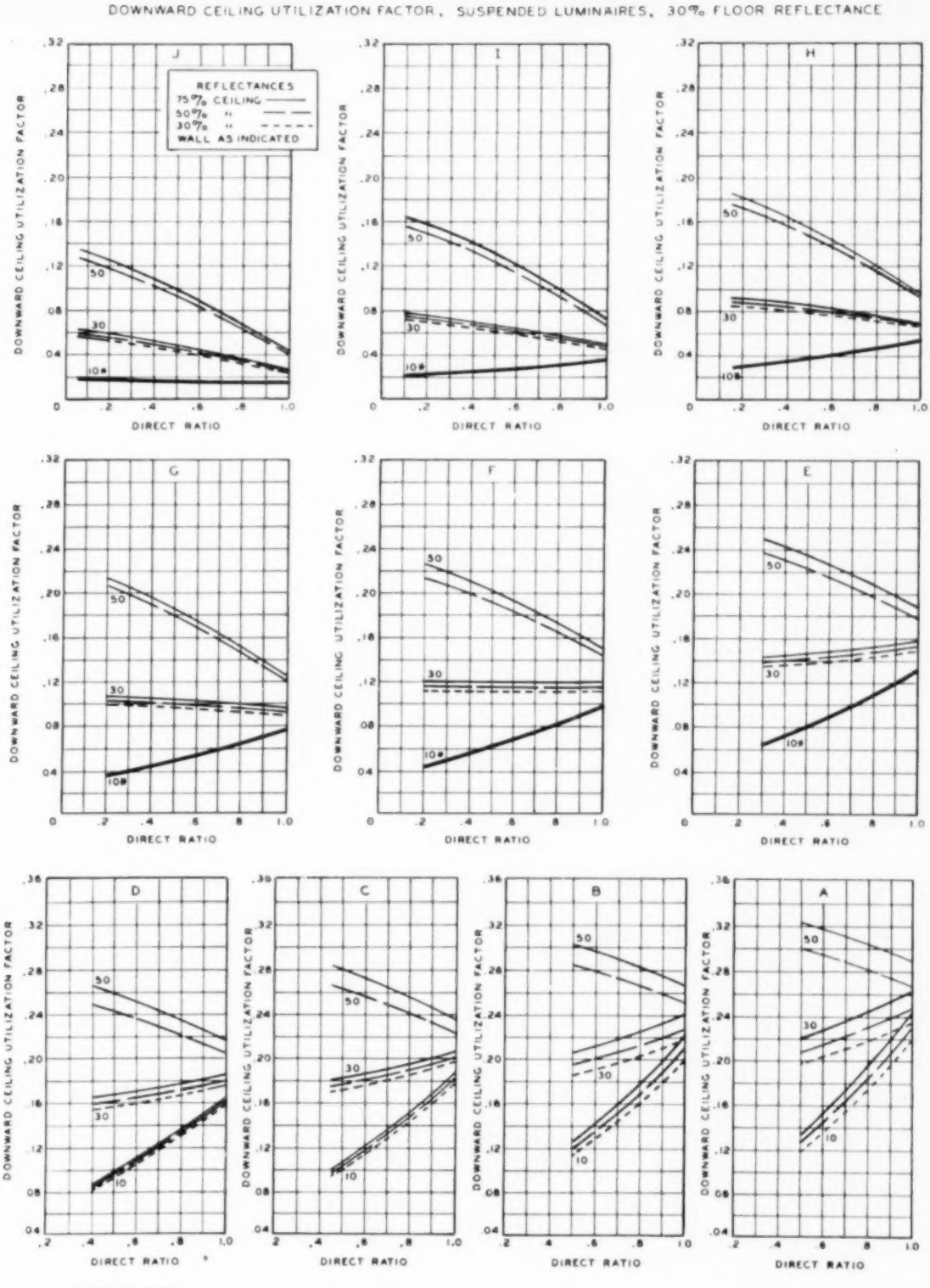


Figure 9b. Downward Ceiling Utilization Factor plotted against Direct Ratio for each room index.

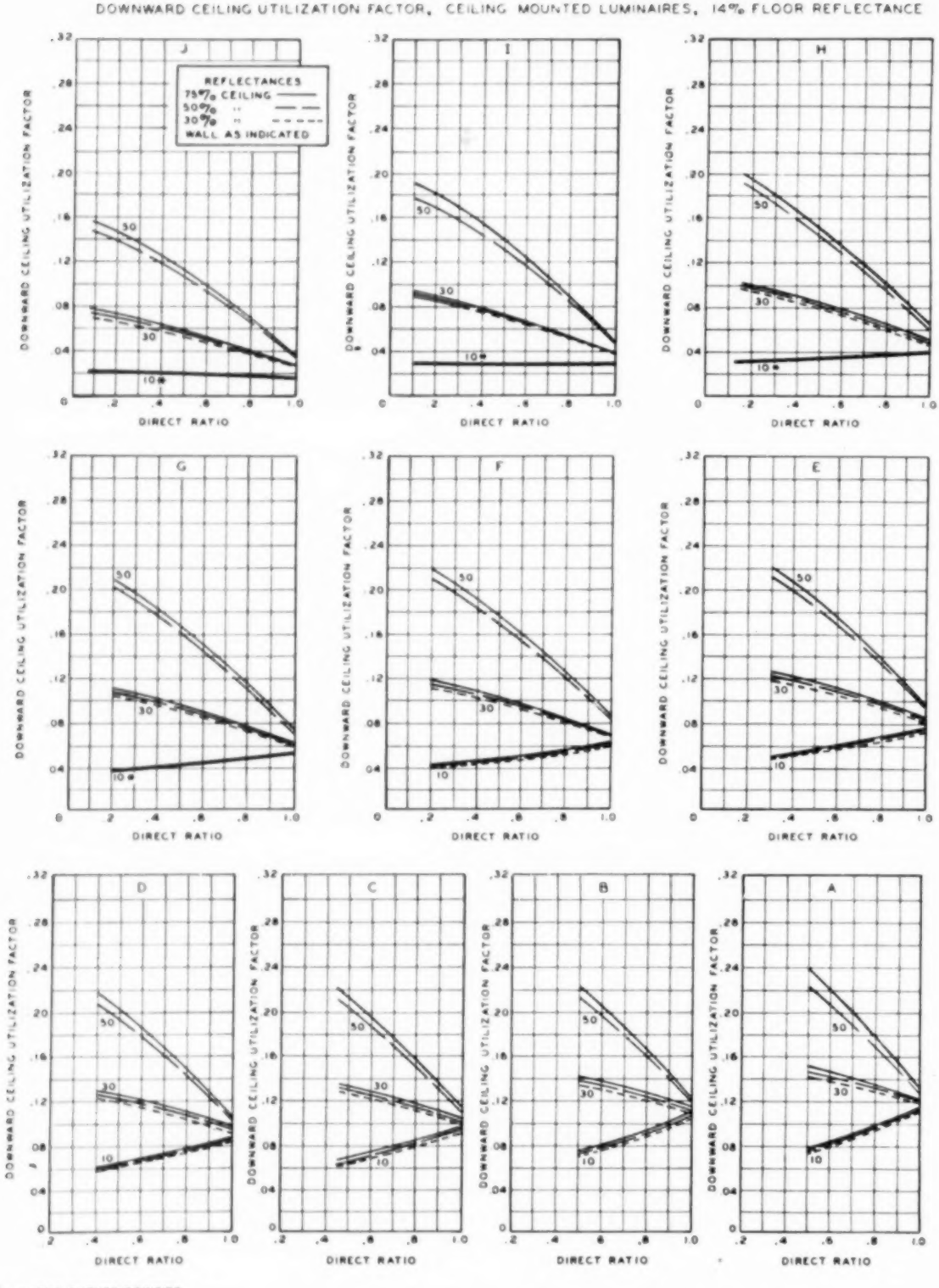


Figure 10a. Downward Ceiling Utilization Factor plotted against Direct Ratio for each room index.

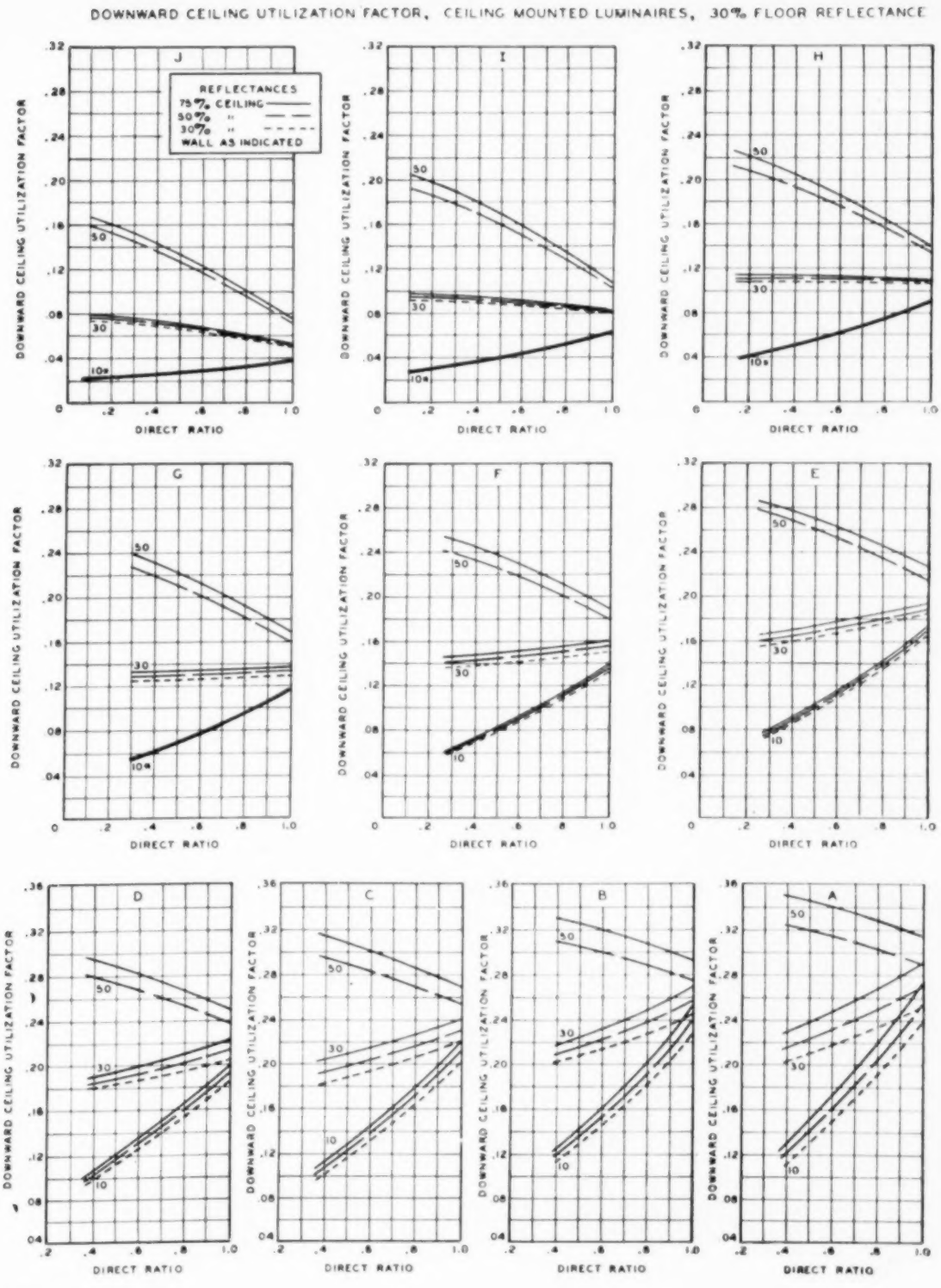


Figure 10b. Downward Ceiling Utilization Factor plotted against Direct Ratio for each room index.

and to make proper adjustments for doors, windows, etc. Also, all coefficients of utilization are based on empty areas. The presence of furniture and other equipment usually tends to reduce the actual coefficient of utilization.

The authors are indebted to Messrs. Clifford Forster and Frank Carter for their assistance in calculating and drawing the curves that were required.

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DISCUSSION

W. M. POTTER*: I wish again to compliment the authors on their important contribution to systematic lighting design data. As I pointed out in discussing their earlier paper, the zonal factor method makes calculated interflection data more generally useful to the practicing engineer. The terminology and form of the utilization tables are familiar and widely accepted.

If this paper appears at first glance more complex than the authors' 1951 material, it is also much more realistic and accurate in relation to actual situations. They have recognized, for example, that all luminaire positions cannot be evaluated adequately in a single set of data. Their paper will help to fill the need for design data of both greater scope and improved accuracy.

For some direct lighting installations we have tested, there has been good agreement between calculated and test results. In other cases, there are differences which may be due, in part at least, to choice of installation pattern and to other conditions assumed for purposes of calculation. The significance of these differences needs careful appraisal.

Our tests on filament indirect installations so far have resulted in coefficients significantly higher than those calculated with zonal factors for the same candlepower distribution.

The authors have presented in this paper revised curves of reflected components. Their earlier data, except as they applied to ceiling mounted direct lighting units, gave coefficients higher than were consistent with the underlying interflection tables. The new and lower values appear in the curves for downward and upward utilization factors for suspended units. Apparently these changes were necessary to correct erroneously selected k_r values for the Room Ratios used in the charts. Room Ratio or Index is based on the distance between work plane and light sources; k_r for the same room depends on over all ceiling height. Hence, there may be many k_r values, with their differing reflected components, for each Room Index.

The reflected component charts for ceiling mounted units are based on 10 foot ceiling height; for suspended units, 13¾ feet is used. In the latter case our application of figures from the interflectance tables did not always yield the exact values as plotted in the paper. It would be helpful if the authors would explain whether any reflected components have been modified because of the altered relationship of work plane and ceiling heights.

Further, what variation do the authors find in the relationship between lumens on the work plane and on the floor, for a given Direct Ratio? Reflectances are not a factor, but how about the effect of different candlepower distributions? Or the fact that in high rooms distance between work plane and floor becomes a small fraction of the mounting height? All computations of downward reflected components depend on this relationship, although in some cases this component may contribute relatively little to the total utilization. The authors have not described explicitly the conditions assumed for this relationship, although one can calculate from their Fig. 4 the numerical ratios they used.

It is important to keep in mind that the values which one obtains from Parts II and III of this paper are the average illumination on, and average brightness of, wall and ceiling surfaces respectively. The usefulness of these over-all averages depends upon the range of variation and the gradients of brightness which actually occur. It is certain, however, that for many installations the most effective designs call for controlled differences in brightness.

KURT FRANCK*: The authors have done a comprehensive job of extending the scope of their previous paper on the same subject. By providing data for spacing-to-mounting height ratios of 0.4 and 1.0 it is now possible to apply the authors' method to a wide variety of installation conditions. It would be interesting to know whether the authors have worked up tables for intermediate values also or whether they feel that straight line interpolation between 0.4 and 1.0 spacing to mounting height ratios is adequate for practical accuracy.

In evaluating the practical usefulness of the authors' method and before applying it extensively to the calculation of lighting results in practice, it is in my opinion important not to overlook the origin of the method. The authors' work is based on the theory of interreflections which relies on several premises rarely, if ever, obtaining in practice.

One of these is the assumption of diffuse reflection of light from walls, ceiling and floor. Actually in practical installations, walls, ceiling, and floor do not provide perfect diffuse reflection but contain a considerable component of specular reflection.

Further, the theory of interreflections assumes that the distribution of brightness and illumination on walls, ceiling and floor is uniform. Again this is seldom, if ever, the case. Walls and ceilings are usually brighter in the immediate vicinity of the luminaire than, say, half way between luminaires.

The question as to what extent these and possible other deviations of practice from theory affect the calculated results can only be answered satisfactorily by actual test and direct comparison of theoretical results with corresponding test results. Some such tests have been made but so far their results are by no means conclusive.

This is not at all a criticism of the authors' work. They have done a worthwhile job of providing a useful tool for handling the interreflection theory. In my opinion the next

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move must now be to corroborate their theoretical figures by an appropriately planned series of actual tests.

WARD HARRISON*: The authors have made a real contribution to the subject of utilization coefficients and they are well entitled to the thanks of this Society for the valuable basic data which they have supplied. I believe we shall appreciate their paper the more as time goes on and we have occasion to make use of it frequently.

There is a question I would like to ask them in regard to their spacing ratios. I presume the reason that coefficients are higher for spacing of 1.0 than for 0.4 is primarily because, in the first instance, the units are farther from the walls. Particularly in small offices lighted by four or six units the spacing between them may be equal to their height but especially where desks are placed against the walls good practice calls for a spacing of something like 0.25 between the units and the wall. What would this make the equivalent spacing ratio for use in these calculations?

The authors have made use of the interreflection tables in their computations. In the last year or two we have heard a good deal about discrepancies between the interreflection tables and the older coefficient of utilization data. An advertisement in the June 1952 issue of ILLUMINATING ENGINEERING (inside front cover) stated that the interreflection tables are 5 per cent low for at least one form of indirect lighting. It also stated that the older coefficient of utilization tables are 30 to 40 per cent low, which would bring them 25 to 35 per cent below the values calculated by the interreflection method. I do not believe that this latter inference is correct.

There is, of course, a real difference in footcandle values obtained in a room with an 80 or 85 per cent ceiling and 65 per cent walls versus a 75 per cent ceiling and 50 per cent walls, but this should not be considered as a difference between the two methods of calculation. Actually much of the test data of 1916 was taken in a room with 81 per cent ceiling and 64 per cent walls. If allowance is made for the proportion of wall area taken up by windows, doors and blackboards, as Jones and Neidhart have emphasized, there will be but few rooms which have an average wall coefficient of more than 50 per cent.

For the same room reflectances the greatest discrepancy that I can find in the old and new published coefficients for the luminaire featured in the advertisement is approximately 16 per cent, and there are three factors which bear upon this difference: (a) In using the interreflection method, it is usually assumed that all the upward light strikes the ceiling, although Jones and Neidhart have guarded against this; (b) the method is also likely to neglect the loss due to the presence of luminaires in the room, whereas under actual conditions they may interfere considerably with light coming from the ceiling; (c) there is no test plate error involved in the interreflection method. As stated in the Harrison-Anderson paper (*Trans. I.E.S.*, 1916, page 67) no correction of their actual readings was made for the departure of their photometric test plate from the cosine law, hence in a large room, with indirect lighting, their readings were low by something like 9 per cent. This lack of correction was deliberate, because at that time and for the most part since then, check readings of illumination are made with instruments having at least that degree of error; dissatisfaction is particularly likely to arise when the level of illumination promised does not seem to be supplied.

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In the above connection, I believe we should be very careful in introducing high floor and table reflectances, such as 30 per cent, into our calculations. In a room with desks, tables, and people, a great deal of the reflected light from below is trapped and absorbed before it can get back to the ceiling and be reflected again to the working plane. It is a generally accepted fact that due to optimistic calculations, lack of adequate maintenance, etc., there are more lighting installations in the world today which give only one half the illumination that they were designed for than there are installations which after long service exceed the design value. The ones we test to establish our factors usually seem to be the installations which enjoy the most favorable conditions. Let us not persuade ourselves too far.

DOMINA EBERLE SPENCER*: It is gratifying to see other illuminating engineers taking on the task of applying the interflection method to commercial luminaires. A casual examination indicates that the Jones and Neidhart method of application appears to be substantially valid though perhaps needlessly complex. As the authors give no details on how their curves were obtained a direct check of the work is not possible. The authors are to be congratulated on the large amount of hard work that they have done.

There is always a question of how elaborate a treatment is required when we come to the application of the interflection method to specific luminaires. Is it necessary to compute separate tables for each luminaire or can we lump together a number of luminaires of similar characteristics? A paper published by Moon and Spencer[1] last year in the *Journal of the Franklin Institute* suggested the possibility of employing only *six* "canonical" candlepower curves as typical of the entire range of hanging luminaires. This would effect a great simplification as compared to the Jones Neidhart paper. Other work on application to commercial luminaires has been done by Coradeschi and Innes,[2] by Burnham and Wakefield,[3] and by Allphin and Spencer.[4] It would be interesting to compare the calculations based on the various possible procedures to see if they are in close agreement with one another and with experiment. Before adopting any one procedure careful investigation is needed to verify its accuracy and to make sure that we are using the simplest possible method.

There is one point, already mentioned by Cutler and Potter, which stands out as a dangerous and unwarranted procedure. Jones and Neidhart have used the old letter indices to specify room shape. John Losh[4] and others have shown that there is little correlation between k_r (domance) and the letter indices. In fact, a single letter index in some cases corresponds to values of k_r covering almost the entire range of values encountered in practice. It is therefore exceedingly regrettable that the authors have chosen to inject the essentially meaningless letter indices into an otherwise useful paper. I suspect that the ingenious illuminating engineer could find cases of startling errors resulting from this cause.

The illuminating engineer can count. He can even divide wall area by floor area. If this is deemed too difficult he can employ the ingenious chart devised by Mr. Allphin or the the tables usually employed by Mr. Martin. Mr. Crouch[8] has reminded us that the numerical room index, k_r, is based on experimental and theoretical investigations circling half the globe. Why then should we be afraid to use a numerical

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specification of room shape? How long must we pretend that the education of the illuminating engineer ended in the kindergarten with the study of the first ten letters of the alphabet?

On the comments of Ward Harrison, I should like to question the details of his numerical examples using a luminous indirect luminaire. According to Burnham and Wakefield[3] the coefficients of utilization for a luminous indirect luminaire, based on the interflection method, are up to 40 per cent greater than the traditional values. Ward Harrison has questioned these coefficients of utilization. My own calculations,[5] based on Mr. Taylor's use of the traditional Harrison-Anderson method in his Pasadena paper,[6] and on the Coradeschi-Innis[2] calculations for the Ainsworth luminous indirect luminaire, indicated a discrepancy as great as 50 to 60 per cent, not the 16 per cent found by Dr. Harrison. A spot check comparison between the coefficients of utilization given for similar luminous indirect luminaires[2, 3] indicates that the differences between the two sets of values seldom exceeds 0.01. The correlation between predicted and mensured quantities of light[3] is better than should have been expected, averaging 5 per cent, yet the theoretical values are lower than the experimental in all cases cited. This would indicate that the coefficient of utilization tables for luminous indirect luminaires based on the interflection method are in excellent agreement with one another and are, if anything, conservative. These discrepancies between traditional predictions for this type of lighting and those based on the interflection method are real. They are not surprising. Many of us have been aware of them for quite a few years.

I would explain the discrepancy by saying that the original Harrison-Anderson[7] data did not include measurements on luminous indirect fluorescent luminaires with high room reflectances (How could they in 1916?) and that the *extrapolations* that were worked out years later have been unduly pessimistic. Failure to use a cosine-corrected meter in the original investigation[7] also tended to give too low coefficients of utilization to all luminaires which do not confine the light to a narrow direct beam. Dr. Harrison factors (a) and (b) are not part of the explanation, for the interflection method does not necessarily assume that all the upward light strikes the ceiling and it does not neglect the loss due to the presence of luminaires in the room.

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R. D. BURNHAM*: While discussing this paper Dr. Harrison referred to an advertisement which appeared in the June 1952 issue of ILLUMINATING ENGINEERING which urged the use of the interflection method, since maximum difference between coefficient of utilization from the Harrison-Anderson data as compared with interflections would be approximately 16 per cent and this only in large rooms. This is substantially true if the Harrison-Anderson method is properly employed. *In the majority of cases it is not.* Today a ceiling reflectance of 85 per cent is the rule rather than the exception, while most Harrison-Anderson tables are based on a ceiling reflectance of 75 per cent and in many cases the average wall reflectance is higher than 50 per cent. Therefore the Harrison-Anderson coefficient of utilization must be increased proportionally for higher ceiling reflectances and for higher wall reflectances. Corrections must also be made in some cases for higher floor reflectance, then another 7 or 9 per cent increase for test plate error in the original test. If these four factors are considered in all calculations as intended by Harrison-Anderson, the discrepancy between the two systems is relatively small. However, in general practice they are excluded.

The June advertisement in I.E. resulted from a series of surveys after which the interflection method was chosen since it seemed to follow the field result more closely as well as offering simplicity due to the expanded tables.

J. R. JONES and J. J. NEIDHART*: The authors wish to thank Mr. Potter, Mr. Franck, Dr. Harrison, Dr. Spencer, and Mr. Burnham for their comments.

Mr. Potter's comments are particularly searching, showing that he is well aware of the limitations that must accompany any method of calculating coefficients for a particular luminaire in a room of a given shape. The number of luminaires installed in a room, their arrangement (symmetrical or non-symmetrical), the length of the suspension hanger, and even the size and reflectance of the luminaire itself all affect the measured footcandle level. But it is impossible to calculate a single coefficient of utilization for a given room shape and set of room surface reflectances that will comprehend all these unknown variables. In the zonal method, we have given consideration to the number of luminaires installed by providing a table of zonal multipliers (Tables I and II) for the 0.4 and 1.0 spacing-to-mounting-height ratios. And in response to Mr. Franck's comments tables for additional ratios are presented.

In this method, it is assumed that luminaires will be arranged symmetrically in a room. This is general practice, but as Dr. Harrison points out, there are exceptions.

The variation in the length of the suspension hanger presents a more serious problem. In some installations the luminaires are suspended a considerable distance below the ceiling. In other cases they have shorter hangers and are nearer the ceiling. To comprehend the variation in hanger length the zonal method employs two sets of data, one for ceiling-mounted luminaires and one for luminaires that will normally be suspended below the ceiling. In compiling data for suspended luminaires it is necessary to assume a length of hanger. The data are based on the assumption that luminaires would be suspended one-half as far below the ceiling as they are above the work plane. This relationship is dictated by the room index structure and formulas. Note that in the room index tables the ceiling height exceeds the mounting height by one-half the distance from the work plane to the mounting height.

In view of the influence that the number of luminaires installed (spacing-to-mounting-height ratio), length of sus-

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*Authors.

pension hanger, and choice of installation pattern may have on the measured footcandle level, it is clear that tests of the accuracy of the method may be of two types, one to test the accuracy of the zonal multipliers and reflected component curves, the other to gather information on the importance of the variations in installation conditions mentioned above. In Mr Potter's tests, the installation evidentally did not duplicate the conditions assumed in the calculations; therefore, his tests were of the latter type, and the authors believe that the results should not be used to check the accuracy of the zonal multipliers or reflected component curves. Mr. Potter's recognition and mention of this is appreciated.

Both Mr. Potter and Dr. Spencer have questioned the method used to equate k_r and room indices, and Dr. Spencer expressed regret that the authors had injected lettered indices into an otherwise useful paper. The various ways of classifying room shapes has caused much confusion. In his classical tests in experimental rooms, Dr. Harrison tabulated his results in terms of a numerical relationship between width and height. Later this was converted to our present room ratio and supplemented by lettered room indices which were advocated to prevent people from multiplying or dividing by the room ratio. While room index letters have been advocated for some time by the Illuminating Engineering Society, room ratios still exist in the room index structure. The authors concede that Dr. Spencer is correct — numerals are better. Ward Harrison also used numerals. Perhaps the I.E.S. should again advocate room ratios, or perhaps Dr. Spencer's room coefficient, k_r. The authors used room index letters in this paper for two reasons: first, they are the standard I.E.S. system; second, they are derived from and readily converted to room ratios, and they in turn may be converted to a room coefficient, k_r, although the latter conversion is somewhat flexible, depending on the ceiling height. The fixed relationship between room index and room ratio, and the conversions between room ratios and room coefficients used by the authors, follow:

Room Index	Room Ratio	Room Coefficient, k_r, Ceiling Mounted Luminaires	Room Coefficient, k_r, Suspended Luminaires
J	.6	1.11	1.53
I	.8	.833	1.15
H	1.0	.667	.915
G	1.25	.534	.734
F	1.5	.445	.611
E	2.0	.333	.458
D	2.5	.267	.367
C	3.0	.222	.306
B	4.0	.167	.229
A	5.0	.133	.183

These conversions between room ratios and room coefficients are predicated on a ceiling height of 10 feet for ceiling mounted luminaires, and 13¾ feet for suspended luminaires. For these ceiling heights the relationship between the room ratio and k_r is fixed, not a variable. The room ratio times k_r for ceiling mounted luminaires is always 0.667; the product of room ratio and k_r for suspended luminaires is 0.92. At the mounting heights listed room ratio appears to the authors to classify room shapes just as adequately as k_r. These are typical ceiling heights for the respective equipment. At other mounting heights the relationship between k_r and room ratio would be slightly different, and the Zonal Method *reflected component curves* (not Direct Ratios) would be presumably exact only at a working plane located one fourth the distance from the floor to the ceiling. This can cause a minor error for other mounting heights, but it will be a smaller one (except for totally indirect luminaires) than is obtained using the Interflectance Method where *all* the flux is calculated for a work plane one fourth the way to the ceiling. Suspended luminaires are also assumed to be mounted 10 feet above the floor in order that the data for the downward flux from semi indirect luminaires may be based on the same room index data (Zonal Multipliers) as the data that are used for predominantly direct luminaires. Thus, the 3¾ foot difference between the mounting height and ceiling height for suspended luminaires is one half the 7½ foot difference between the work plane height and mounting height. As was mentioned earlier this one half to one relationship was dictated by the room ratio formulas for predominantly direct and predominantly indirect luminaires. The room ratio formulas and the derivation of the one half relationship follow:

For predominantly direct luminaires:

$$\text{Room Ratio} = \frac{\text{Width} \times \text{Length}}{(\text{Width} + \text{Length}) \times \text{Mounting Height above Work Plane}}$$

For a square room this simplifies to

$$RR = \frac{W}{2 \times MH_{wp}}$$

For predominantly indirect luminaires:

$$\text{Room Ratio} = \frac{3 \times \text{Width} \times \text{Length}}{2\,(\text{Width} + \text{Length}) \times \text{Ceiling Height above Work Plane}}$$

And for a square room this simplifies to

$$RR = \frac{3W}{4CH_{wp}}$$

By equating the simplified formulas the relationship between mounting height above the work plane and ceiling height above the work plane is obtained:

$$\frac{W}{2 \times MH_{wp}} = \frac{3W}{4CH_{wp}}$$

$$\text{and} \quad MH_{wp} = \tfrac{2}{3} CH_{wp}$$

Thus, for all the Zonal Method data to apply the suspended luminaire must be suspended one half as far below the ceiling as it is above the work plane. If a luminaire does not have such a long suspension hanger the indirect luminaire will direct a larger percentage of its flux to the ceiling (higher Ceiling Ratio), and reference to Fig. 3a or 3b will show that the calculated coefficient of utilization will be lower than the measured value. Mr. Potter suggested that this is what happened in his tests, and the authors quite agree, because luminaires are normally mounted nearer the ceiling. The authors did not modify the reflected component curves to correct for this minor discrepancy between practice and theory although they considered it. If the room index formula for indirect luminaires should be modified it should be done by the Lighting Design Practice Committee, because this discrepancy is not peculiar to the Zonal Method, but applies to any system using the Lumen Method room ratio formulas.

Of course, the Interflectance Method does not use these formulas, but bases everything on ceiling height, and the major source of error will occur in the use of direct luminaires. The authors agree with Dr. Spencer that the ceiling height (as included in k_r) is of prime importance in calculating the light *reflected* to the work plane, but it has nothing to do with the light that strikes the work plane *directly* (Direct Ratio). The mounting height is important

TABLE D-1.—Zonal Multipliers (0° to 90°) for 0.6 Spacing-to-Mounting-Height Ratio.

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	.81	.86	.87	.90	.92	.94	.95	.96	.97	.97
20-30	.67	.75	.79	.84	.87	.90	.92	.93	.95	.95
30-40	.30	.47	.55	.65	.69	.77	.82	.85	.88	.91
40-50	.15	.35	.47	.56	.63	.71	.77	.81	.85	.88
50-60	.02	.12	.28	.39	.48	.60	.67	.72	.79	.83
60-70	—	—	.04	.18	.29	.42	.52	.59	.69	.76
70-80	—	—	—	—	—	.10	.21	.32	.47	.58
80-90	—	—	—	—	—	—	—	—	.04	.13

TABLE D-2.—Zonal Multipliers (0° to 90°) for 0.7 Spacing-to-Mounting-Height Ratio.

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	.86	.90	.91	.93	.94	.96	.96	.97	.98	.98
20-30	.72	.79	.83	.87	.89	.92	.93	.94	.96	.96
30-40	.28	.45	.54	.63	.69	.77	.82	.85	.88	.91
40-50	.15	.24	.46	.55	.62	.71	.77	.81	.85	.88
50-60	.02	.13	.28	.39	.48	.60	.67	.72	.79	.83
60-70	—	—	.04	.17	.28	.42	.52	.59	.69	.76
70-80	—	—	—	—	—	.10	.21	.32	.47	.58
80-90	—	—	—	—	—	—	—	—	.05	.12

TABLE D-3.—Zonal Multipliers (0° to 90°) for 0.8 Spacing-to-Mounting-Height Ratio.

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	.91	.93	.94	.95	.96	.97	.97	.98	.98	.99
20-30	.76	.82	.86	.89	.91	.93	.94	.95	.96	.97
30-40	.25	.43	.53	.62	.68	.76	.81	.84	.88	.90
40-50	.15	.33	.45	.54	.61	.71	.76	.80	.85	.87
50-60	.01	.13	.27	.39	.48	.60	.67	.72	.79	.83
60-70	—	—	.03	.16	.26	.41	.51	.58	.68	.75
70-80	—	—	—	—	.01	.10	.21	.31	.46	.57
80-90	—	—	—	—	—	—	—	.01	.05	.11

TABLE D-4.—Zonal Multipliers (0° to 90°) for 0.9 Spacing-to-Mounting-Height Ratio.

Zone (Deg.)	J	I	H	G	F	E	D	C	B	A
0-10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10-20	.95	.96	.97	.98	.98	.98	.99	.99	.99	.99
20-30	.81	.86	.89	.91	.93	.95	.96	.96	.97	.97
30-40	.23	.42	.53	.61	.68	.76	.81	.84	.88	.90
40-50	.14	.33	.44	.54	.61	.70	.76	.79	.84	.87
50-60	—	.13	.27	.39	.48	.60	.67	.72	.80	.83
60-70	—	—	.02	.14	.25	.41	.51	.58	.68	.75
70-80	—	—	—	—	.01	.09	.20	.31	.46	.56
80-90	—	—	—	—	—	—	—	.01	.05	.11

in this case because direct luminaires may be mounted a considerable distance below the ceiling. This can make a tremendous difference. The Interflectance Method needs the Direct Ratio concept and the authors believe that the use of Lumen Method room index formulas is the only way to accomplish this successfully.

To find the illumination on the floor the authors suggest, in answer to Mr. Potter, that the room index be recalculated after adding 2½ feet to the mounting height or ceiling height and using the coefficient of utilization for the new room index. The error introduced by this scheme is small.

Mr. Franck has very appropriately asked if zonal multipliers for spacing to mounting height ratios between 0.4 and 1.0 have been calculated. Many were calculated and while the individual multipliers did not fall on a line of interpolation between the corresponding ones for 0.4 and 1.0 spacing to mounting height (above the work plane) ratios, the Direct Ratios calculated from them did form a smooth curve with the Direct Ratios of 0.4 and 1.0 spacing ratios. Since the zonal multipliers are used only to obtain the Direct Ratio, the authors feel that the interpolated multipliers presented here are wholly satisfactory and well within the limit of practical accuracy.

The authors would like to point out that the assumed perfectly diffusing room surfaces of the Interflectance Method do exist, for practical purposes, in some installations, and also that the brightness distribution of the ceiling, at least, is substantially uniform in some installations. As far as the authors know, prior to the introduction of the Interflectance Method, lighting engineers were never concerned with either of these criteria when explaining a deviation between calculated and measured illumination levels. Perhaps their importance is overemphasized now. However, it is not difficult to imagine that non-uniformity of wall brightness is a factor worthy of consideration in high narrow areas. We understand a study of this is being made by Mr. Robert Wiseman at the University of Illinois. His results will be most interesting.

Dr. Harrison has raised a question concerning the effect of placing luminaires unusually near to the walls in small offices. This is a non symmetrical arrangement of luminaires that will lower the measured coefficient of utilization. If, in a room 12 feet square and 12½ feet high, a luminaire is located in each corner two feet from each wall the Direct Ratio will be lower than would be obtained using zonal multipliers for the 0.4 spacing ratio. It would be about as much below that of the 0.4 spacing ratio as that of the 0.4 ratio would be below that of the 1.0 spacing ratio. This approximation is based on a luminaire having a spread distribution. Dr. Harrison is correct in concluding that the important consideration is the distance between the luminaires and the wall, not actually the distance between luminaires.

A listing of the I.E.S. National and Local Officers will be found on pages 18A and 21A of this issue. The list of Committee Personnel starts on page 22A.

INSTALLATION AT WESTERN ELECTRIC COMPANY, KEARNY, NEW JERSEY.

Lighting a Large Office

LIGHTING OBJECTIVE: To provide high-quality illumination in a large general office area.

GENERAL INFORMATION: The area shown above is 60 x 420 feet with a ceiling height of 12 feet 4 inches. Colors and reflectances are as follows:

ceiling	eggshell	80% RF
walls	light green	60% RF
floor	mottled green	20% RF
desk tops	mist green	65% RF
desk fronts and chair backs	medium gray	30% RF
filing cabinets	medium gray	30% RF

INSTALLATION: Mounted 10 feet 8 inches above the floor are 252 Day-Brite Luvex (#96265) luminaires each containing two 3500K white 96-inch T-12 fluorescent lamps. Over the aisle are installed 45 matching 48-inch units (#46265).

Average illumination after two months' use was 60 footcandles at desk height. Fig. 2 shows illumination levels measured at specific points.

(over)

A.I.A. File No. 31f

Brightnesses are as follows:

Ceiling		
above luminaire	(max)	210 ft-L
⅙ distance between luminaires		50 ft-L
midway between luminaires	(min)	27 ft-L
Luminaire		
bottom	(avg)	250 ft-L
side		59 ft-L
Wall		
at column 6 feet above floor		32 ft-L
end wall		15 ft-L
Desk top		
at end of row		36 ft-L
at center of row		43 ft-L
at aisle		37 ft-L
Floor		11 ft-L

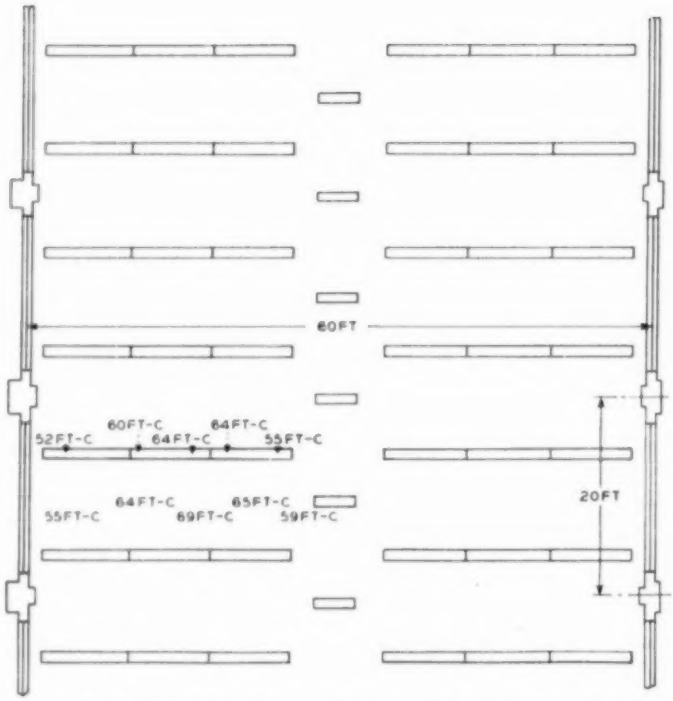


Figure 2. Plan view showing illumination distribution in one bay.

Because of perspective, the luminaires completely shield the ceiling for the last 200 feet of room when viewed from far end in sitting position. The luminaire sides for the last 150 feet blend into a uniform brightness of 36 footlamberts.

Lighting designed by Paul Lindholm, Department Chief, Plant Engineering, and David Hughes, Lighting Engineer, of Western Electric.

Lighting data submitted by Paul Lindholm, Western Electric Company, Kearny, N. J., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Questions and Answers on light sources

The I.E.S. Committee on Light Sources, under the chairmanship of G. S. Evans, has prepared the following discussion as an answer to questions frequently asked concerning power factors in circuits containing electric discharge lamps. Readers are invited by the Committee to submit questions of general interest on light sources, to be considered for publication from time to time. Questions may be sent in care of the Society Headquarters.

The Power Factor of Electric Discharge Lamps

Power in watts in an alternating current device is the product of the current in amperes, the electromotive force in volts, and the cosine of the phase angle between current and voltage when the wave form is sinusoidal. This cosine is known as the power factor.[1]

When the current and voltage wave forms are sinusoidal and in phase, the phase angle is zero, the cosine is unity and the power factor is one. For all other values of the phase angle, the cosine is less than unity, and, hence, the power factor is less than one.

The current and voltage in electric discharge lamps are in phase, but the wave forms are not sinusoidal, and contain frequencies other than the fundamental. This condition results from the fact that the voltage across a discharge lamp at a given instant is a function not only of the current at that instant, but also of the current at earlier times. Since the voltage depends on the shape of the whole current wave form, the discharge lamp becomes an efficient source of harmonics.

Because of the distortion of the wave form, and even though the phase angle is zero, electric discharge lamps have an *apparent* power factor less than unity. This *apparent* power factor is usually between 0.90 and 0.97. The power in the lamp is the product of current, voltage, and this apparent power factor.

The auxiliary equipment required to operate electric discharge lamps may in itself produce an out-of-phase condition in the electric circuit. This phase shift results usually from the existence of an inductive element in which the voltage leads the current. A capacitive element would have just the opposite effect, the current would lead the voltage. Either of these conditions will provide a power factor of less than unity.

A power factor less than unity indicates the existence of a wattless current component which does not work, i.e., does not produce light. This extra current, while frequently free to the user since it does not register on a watthour meter, does complicate the circuits and controls. When appreciable, it must be partially eliminated by application of suitable correction.

Correction can apply only to the out-of-phase condition. Since the current and voltage in the discharge lamp are in phase, the apparent power factor of the lamp cannot be corrected. The power factor of the circuit can be corrected, at least in part, by the introduction into the circuit of sufficient capacitance (or inductance) as required. The added capacitance should be connected to the electric supply mains, preferably near the ballast for the lamp. Connection across the lamp terminals is to be avoided as this may cause improper lamp operation and produce a condition which will lead to rapid deterioration of the lamp.

There are many types of power-factor corrected ballasts commercially available for electric discharge lamps. The method of power-factor correction employed varies as to the particular ballast circuit used.[2]

References

1. *I.E.S. Lighting Handbook*, Second Edition, p. 3-11.
2. *I.E.S. Lighting Handbook*, Second Edition, pp. 8-31 to 8-32, 8-51 to 8-52, Figs. 8-43 and 8-46.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

February Council Meeting in New York, Summary of Action Taken

The bi monthly meeting of the I.E.S. Council was held February 12, at the Lexington Hotel, New York City. President S. M. Strong presided. Attending were: Past Presidents, S. G. Hibben, Walter Sturrock; Vice Presidents A. H. Manwaring, D. M. Jones; General Secretary, C. C. Keller; Treasurer, K. M. Reid; Directors G. W. Beals, M. Fahsbender proxy for C. R. Long, R. A. Palmer, J. F. Whitehead, Jr., F. C. Winkler; Regional Vice Presidents R. L. Biesele, Jr. proxy for W. E. Folsom, P. H. Hildebrand, H. G. Clum proxy for L. A. Hobbs, F. P. Labey, W. J. Lind, L. B. Paist, L. C. Twichell; Executive Secretary, A. D. Hinckley; Technical Director, C. L. Crouch; Editor, Ruby Redford, and Dan Dunne, C. H. Goddard, C. C. Shotwell and L. E. Tayler.

Following the approval of proxies, discussion and approval of the Minutes of the Executive Council meeting in January, and a study of the Society's financial status, Council took action on the report of Board of Examiners. Acting on the Board's recommendation, Council voted unanimously to elect to the grade of Member Emeritus, Dr. A. F. Dickerson and Chester L. Dows. Dr. Dickerson retired recently from the General Electric Co., Lynn, Mass., where he was one of the country's leading street lighting experts. He has been a member of the I.E.S. Street and Highway Lighting Committee for some 25 years. Mr. Dows, a well-known physicist at General Electric, Nela Park, and also a valuable contributor to I.E.S., retired recently from the company's Lamp Division.

Local Activities

Duncan M. Jones, Chairman, reported on the meeting of the Local Activities Committee held February 11. He outlined the large amount of work required of Regional V-Ps for their successful operation, and emphasized the importance of their activities. He suggested the development of a list of speakers to be available to Section and Chapter Program chairmen.

Membership Statistics

Council also acted on the recommendation of the Board of Examiners in the election of 20 new Members. Also reported were the election, by the Board, of 112 Associate Members and 7 Students. The current membership of I.E.S., by grades, following this action, is shown in the following tabulation:

September 30, 1952		February 12, 1953
7394	Total Membership	7749
34	Members Emeritus	33*
41	Fellows	54
1797	Members	1848
5293	Associate Members	5531
229	Student Members	283

*Includes 12 Fellows.

Committee Appointments

A number of new committees and new committee personnel were approved by Council. An up to date listing of all I.E.S. Committees and personnel, including the February appointments, is given in the back pages of this issue.

Publications

A report was made to Council by Duncan M. Jones, Chairman of the Publications Committee on the Society's publication program. He showed them a portable display case recently designed and built, several of which are to be made available to Sections and Chapters for display of I.E.S. publications at local meetings and Regional Conferences. The case, a very readily portable affair weighing about 20 lbs. is an attractive display of all the Society's published material, including the Handbook, samples of all being included. Mr. Jones indicated distribution would be through the Regional Vice-Presidents.

Further on the subject of displays, he noted that the I.E.S. would have a booth at the forthcoming E.E.I. Conference in Chicago, this booth also a part of the publications program.

Reporting the president status of the I.E.S. Lighting Handbook, Second Edition, Mr. Jones noted that the cost of this project will be liquidated with the sale of the next 300 copies and that the first printing is expected to be out of stock by June. Plans are underway, he said, for a second printing of this edition in approximately June or July.

For the information of Council, Mr. Jones reported that 5000 copies of recent house ads featuring I.E.S. services were being reprinted for the use of the Membership Committee and other committees interested.

Sustaining Members

C. C. Shotwell, Chairman of the Sustaining Membership Committee outlined to Council the response to his Committee's program "Operation Utility" and other programs for stimulating company support of the Society's work. He indicated that more local activity is required for the success of these programs and urged further aid to local plans.

For election to Sustaining Member he recommended and received the approval of:

C. W. Cole & Co. Inc.
320 E. 12th Street
Los Angeles 15, Calif.
Official Representative: Russell W. Cole

Electrical Products Corporation
1100 North Main Street
Los Angeles 12, Calif.
Official Representative—L. A. Rice

Morris Kurtzon, Inc.
1420-30 South Talman Avenue
Chicago 8, Ill.
Official Representative—David Koch

A. Edward Simpson
445 Richards Street
Vancouver, B. C.
Official Representative—A. E. Simpson

Southwestern Electric Company
120 South Hewitt Street
Los Angeles 12, Calif.
Official Representative—Edward C. Meyer

United Wholesale Supply Corp.
10021 So. Broadway
Los Angeles, 3, Calif.
Official Representative—Sam M. Neely

New Chapter

Petition was made for Chapter Charter for a group of members in Birmingham, Alabama. Petition of this group was presented by A. D. Hinckley in the absence of R. C. Paslay, Regional V-P. The group qualified in all respects for Chapter status, and Charter was approved for the

(Continued on page 9A)

Here and There with I.E.S. Members

At the January 15 meeting of the St. Louis Section (above) Don P. Caverly, Sylvania Electric Products Inc., was guest speaker. Left to right at head table are Brooks Chassaing, Program Chairman; W. H. Simms; Don P. Caverly; L. M. Wallace Jr., Section Chairman; E. C. Ryan and Richard Cohen. Attendance was 104.

In the photo at left, William Shalda (left), Shalda Manufacturing Company, receives a welcome as Sustaining Member from E. E. Coleman, Southern California Section's Chairman of Sustaining Membership Committee, at Section meeting January 7. Roy E. Dahlin, Section Chairman is in background.

Recently-formed Vancouver Island Chapter received its Charter from Regional V-P Walter Lind, December 13. Left to right are Percy F. Fletcher; Vice President Lind; Kenneth Reid, Chapter Chairman; Morris Murphy; George Langdon and Earle S. Jarvis, Secretary-Treasurer. Chapter headquarters are in Victoria, B.C.

Joint meeting of the I.E.S. Office Lighting Committee and School Lighting Committee was held at the Park Sheraton Hotel, New York City, January 22. Presiding are J. J. Neidhart, Chairman of Office Lighting Comm., and John Chorlton, School. The two technical committees have mutual interest in the problem of brightness limitations of luminaires.

Charlie Johnson, on his retirement from Curtis Lighting, reversed the normal procedure by inviting top executives and lighting men of the distributors with whom he has been most closely associated to a luncheon on January 6. The purpose was to thank them for their cooperation and to announce his plans to serve as independent Lighting Consultant. His many friends took the opportunity to express their confidence in his future success.

KNOW YOUR SOCIETY—

Meet Your Regional Vice-President

Pause right here. Recognize your Regional Vice-President, the man you should meet and whose duties you should know about. You elected him to represent you at Council and Local Activities Committee meetings every two months. His term of office is two years and he brings to these meetings your problems and an account of your Section or Chapter activities. He learns of what other Regions are doing and takes back this information to you. The Society expects him to give assistance and guidance and leadership to all your Sections and Chapters.

P. H. Hildebrand

East Central Region

Eastern Penna. Section
Capital Section
Maryland Section
Philadelphia Section
Pittsburgh Section

W. J. Lind

Pacific Northwest Region

British Columbia Section
Inland Empire Chapter
Oregon Section
Puget Sound Section
Vancouver Inland Chapter

G. J. Taylor

Northeastern Region

Connecticut Section
Eastern New York Chapter
New England Section
New York Section

L. A. Hobbs

South Pacific Coast Region

Mother Lode Chapter
Northern California Section
San Jose Chapter
Southern California Section

You will meet him, and in person, for one of these days he will load his valise and brief case and be off to visit your Section or Chapter. He will meet with your officers and discuss with them their plans and programs. He will be the speaker at one of your regular meetings and will likely tell you all about the Society's operations, the function and purpose of its many National and Technical Committees.

R. C. Paslay

Southern Region

Alabama Chapter
Carolinas Section
Florida Chapter
Georgia Section
Mid South Chapter
Mississippi Chapter
New Orleans Section
Southeast Florida Chapter
Tennessee Valley Section

L. B. Paist

Midwestern Region

Iowa Section
Milwaukee Section
St. Louis Section
Twin City Section
Twin Ports Chapter
Central Illinois Chapter
Chicago Section
Cornhusker Chapter
Heart of America Section
Indiana Chapter

His correspondence is voluminous. At the start of the year he forms his Regional Nominating Committee who determine those men in your Region capable and willing to stand for National office and future Regional Vice-President. He answers questions on the Constitution and By-Laws and Society procedure. He analyses budgets and gives guidance on expenditures. He arranges for the appointment of Section and Chapter representatives to National Committees such as Membership, Sustaining Membership, Public Relations and Information and Data Sheet Committees. He officially appoints, upon recommendation from Sections and Chapters, the Local Representatives and tries to create some activity through them. He helps and instigates extension work, in the formation of new Chapters and Student Branches. He attends their Charter nights. These are only a few of his most important responsibilities.

L. C. Twichell

Great Lakes Region

Central New York Section
Cleveland Section
Michigan Section
Northwestern Ohio Chapter
Ohio Valley Section
Rochester Section
Western Michigan Chapter
Western New York Section

F. P. Labey

Canadian Region

Hamilton Ontario Chapter
Maritime Chapter
Montreal Section
Ottawa Chapter
Quebec Chapter
Toronto Section
Winnipeg Chapter

Finally you will meet him at your Regional Conference where he will hold a Local Activities meeting attended by National officers present, your officers and members. There, all can express their opinions, comments and suggestions and learn more about your Society. He helps in the planning of the conference, the formation of committees, the speakers, the budget and the many other functions that go to make a successful conference. In short, it is his conference and in its performance shows the enthusiasm and progressive spirit of all those members that go to make up a Region.

H. T. Rankin

Inter-Mountain Region

Arizona Chapter
New Mexico Chapter
Rocky Mountain Section
Southern Colorado Chapter
Utah Chapter

W. E. Folsom

Southwestern Region

Alamo Chapter
Oklahoma Chapter
San Jacinto Section
Southwestern Section

new group, to be known as the Alabama Chapter.

Petition was also made, and Charter granted, for a new Student Branch of I.E.S. at the Oregon State College, Corvallis, Oregon. Faculty Advisor for this group will be Professor D. W. Shirley, Jr.

The Society's technical program was reported to Council by C. L. Crouch, Technical Director, and A. H. Manwaring, Senior Vice-President. Reports were also presented by C. C. Keller (in the absence of Hoyt P. Steele) on the financial and other plans to date for the New York National Technical Conference, and by Charles H. Goddard for the Committee on Procedures and Policies.

President Strong told Council details of his recent visits with local officers in Moncton, St. John and Montreal, and mentioned his great gratification in the enthusiasm and good work evidenced by these and other Canadian groups.

Visual Comfort Ideals Stressed at Educators Convention

Almost all of the several hundred displays at the Atlantic City Convention of the American Association of School Administrators (February 14-19) featured visual comfort as a major virtue of their products. These included school furniture manufacturers, chalkboards, paint, flooring, school house design and numerous related fields. Oddly enough, only four manufacturers of lighting equipment were represented. These, and a display by the Better Light Better Sight Bureau, experienced considerable interest in school lighting, by the 16,000 school administrators attending.

The six-day Convention, one of the country's largest, was held at Convention Hall, Atlantic City, N. J., and featured in addition to some 300 displays, a comprehensive program of papers.

New Mexico Chapter Participates In University Plant Program

About 30 universities and colleges in the Rocky Mountain area were represented at the First Meeting of Physical Plant Directors of Universities and Colleges, held February 23-25 at the University of New Mexico, Albuquerque. The New Mexico Chapter of I.E.S. was invited to participate and presented a session on "Exterior Lighting."

S. G. Newman, L. M. Wallace, both of Westinghouse Electric Corp., and Stanley Bazant, Jr., Chapter Chairman, Public Service Co. of New Mexico, covered the subject of campus street lighting and interior campus lighting of pathways, walks, etc. Actual demonstrations were set up and discussed. An 88-unit, 20,000-lumen mercury vapor street lighting installation was turned on for the first time. The standards are 30-foot aluminum poles with 6-foot bracket arms, installed in a staggered arrangement with average pole spacing of 170 feet.

Robert G. Dummel, Holophane Co., Inc., concluded the session, speaking on "Light Control."

LIGHTING CALENDAR

Society Events

March 23-24, 1953—Canadian Regional Conference, Chateau Laurier, Ottawa, Ont.

April 2-3, 1953—Pacific Northwest Regional Conference, Hotel Benson, Portland, Ore.

April 9-10, 1953—South Pacific Coast Regional Conference, Los Angeles, Calif.

April 13-14, 1953 — Southwestern Regional Conference, Hotel Baker, Dallas, Texas.

April 13, 1953 — Meeting of I.E.S. Council, Dallas, Texas.

April 30 - May 1, 1953 — Midwestern Regional Conference, Hotel Radisson, Minneapolis, Minn.

May 14-15, 1953 — East Central Regional Conference, Hotel Lord Baltimore, Baltimore, Md.

May 18-19, 1953 — Southern Regional Conference, Sedgefield Inn, Greensboro, N. C.

May 25-26, 1953 — Great Lakes Regional Conference, Syracuse Hotel, Syracuse, N. Y.

September 14-18, 1953 — Illuminating Engineering Society, National Technical Conference, Commodore Hotel, New York, N. Y.

Industry Events

March 9-12, 1953 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

March 30 - April 2, 1953 — Annual Sales Conference, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.

April 27 - May 1, 1953 — Society of Motion Picture and Television Engineers, Hotel Statler, Los Angeles, Calif. Semi-Annual Convention.

April 13-14, 1953 — Annual Convention of the Electrical Contractors Association of Ontario, Royal Connaugh Hotel, Hamilton, Ont.

April 28-30, 1953 — The American Society of Mechanical Engineers (Spring Meeting), Deshler-Wallick Hotel, Columbus, Ohio.

May 7-8, 1953 — Public Utilities Advertising Association, Annual Convention, Hotel Chase, St. Louis, Mo.

May 18-22, 1953 — National Materials Handling Exposition, Convention Hall, Philadelphia, Pa.

May 19-22, 1953 — Electrical Manufacturers Representatives Association of Michigan, Exhibition Building, Michigan State Fair Grounds, Detroit, Mich.

May 24-28, 1953 — National Association of Electrical Distributors, 45th Annual Convention, Conrad Hilton Hotel, Chicago, Ill.

June 1-4, 1953 — 21st Annual Convention, Edison Electric Institute, Atlantic City, N. J.

June 9-12, 1953 — Store Modernization Institute, Fourth Annual Modernization Show, Madison Square Garden, New York, N. Y.

June 28 - July 2, 1953 — American Society of Mechanical Engineers, Semi-Annual Meeting, Statler Hotel, Los Angeles, Calif.

June 15-19, 1953 — Summer General Meeting, American Institute of Electrical Engineers, Atlantic City, N. J.

August 18-21, 1953 — Pacific General Meeting, American Institute of Electrical Engineers, Vancouver, B. C.

September 21-26, 1953 — 25th Jubilee Meeting, International Association of Electrical Inspectors, Edgewater Beach Hotel, Chicago, Ill.

September 23-25, 1953 — Annual Meeting, Canadian Electrical Manufacturers Association, General Brock Hotel, Niagara Falls, Ont.

October 5-9, 1953 — Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y. Semi-Annual Convention.

October 19-21, 1953 — American Standards Association, 35th Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 19-23, 1953 — 41st National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

November 9-13, 1953 — National Electrical Manufacturers Association, Haddon Hall Hotel, Atlantic City, N. J.

November 17-19, 1953 — National Electrical Contractors Association, Miami Beach, Fla.

November 29 - December 4, 1953 — The American Society of Mechanical Engineers (Annual Meeting), Statler Hotel, New York, N. Y.

January 18-22, 1954 — Winter General Meeting, American Institute of Electrical Engineers, New York, N. Y.

March 8-11, 1954 — National Electrical Manufacturers Association, Edgewatar Beach Hotel, Chicago, Ill.

I.E.S. Research Fund Reports On Progress of Projects

The status of research being carried on under I.E.S. Research Fund projects was reported recently by the Fund's Board of Trustees. A limited number of mimeographed copies of this report, which outlines the nature of the projects and their progress toward completion and publication, are available from the Technical Office, Society Headquarters.

April Council To Meet in Dallas

The meeting of I.E.S. Council scheduled for April 13, will be held in Dallas, Texas, just prior to the Southwestern Regional Conference.

A large attendance is expected, from western and southern members of Council, as well as other officers who will be in Texas for the Regional Conference. The meeting is scheduled at the Baker Hotel, Monday, April 13.

Georgia Groups of I.E.S. Hold Joint Meeting in Atlanta

Some hundred members and guests attended a joint dinner meeting of the Georgia Section and the Atlanta Residence Lighting Forum on January 26, at the Y.W.C.A. J. Dixon Mitchell, Section Chairman, presiding. Miss Nina Faye Bonner, Forum Chairman, welcomed the guests and new members and introduced Program Chairman Mrs. Fred B. Wenn.

Guest speaker was Mrs. May Love Gale, District Home Supervisor for Tennessee Valley Authority, who gave an illustrated talk on "A Tennessee Home in a New Light," the paper she had presented at the Washington Conference.

"Recessed Lighting" was the subject for discussion at the Study Club, which was held prior to the regular meeting at the Georgia Power Company's Director's Room with Wesley F. Johnson, Chairman of the Educational Committee, presiding. Dewey L. Johnson, Superintendent of Electrical Affairs for the City of Atlanta, spoke on "Code Requirements for Recessed Lighting." Glen H. Arnold, manufacturer's representative, discussed "Methods of Installations." "Applications of Recessed Lighting" was presented by John E. Sweatte, Georgia Power Company. Attendance at the Study Club was 56.

City Mayors and Police Chiefs Attend Cleveland Street Lighting Clinic

City Mayors, Police Commissioners and administration executives from a number of cities in Ohio, Michigan, New York and Pennsylvania traveled to Cleveland recently to attend an exceptionally successful conference on street lighting for safety, sponsored by the Cleveland Section of the I.E.S. Approximately 150 persons attended.

Four outstanding speakers were presented: D. M. Baldwin, National Safety Council Director; H. W. Hoyt, chief of Police, Kalamazoo, Mich.; L. M. Johnson, Commissioner of Streets and Electricity, Chicago, Illinois; and H. V. Ryder, Supervisor of Street Lighting, Philadelphia Electric Company. Special temporary Chairman for the conference was William A. Porterfield, Union Metal Mfg. Company, Canton, Ohio.

Poor illumination of city streets was revealed as the number one factor in after dark accidents and crime by all of the speakers. Engineers and city government people present heard four phases of this problem presented, with constructive discussion on its solution.

Stature of the Cleveland Section's street lighting conference is evidenced by the news value it elicited from all news services—press, television and radio.

Dana W. Rowten, Westinghouse Electric Corp., and Chairman of the Cleveland Section was in charge of the meeting.

Lighting Session Presented At A.I.E.E. Conference

An afternoon session on Light Sources and Control Devices was given at the Winter General Meeting of the American Institute of Electrical Engineers, January 24. Program and speakers were:

Filament Sources. Kirk Reid, General Electric Co.
Mercury and Vapor Sources. Eugene Beggs, Westinghouse Electric Corp.
Fluorescent Sources. Theodore Sargent, Sylvania Electric Products, Inc.
Ballasts and Circuit Control Devices. W. C. Anderson, Jefferson Electric Co.

The Winter General Meeting was held January 19-23 at the Hotel Statler, New York City.

Lighting Fundamentals Course Being Given in Kansas City

A ten-session course on fundamentals of illumination is currently being sponsored by the Heart of America Section, I.E.S. Designed as both a refresher course and an introduction to lighting, the two-hour classes are as follows:

February 19—The Need for Lighting, by M. A. Havenhill, Kansas City Power and Light Co., Kansas City, Mo.
March 5—Light Sources—Filament and Mercury, by L. M. Wallace, Jr., Westinghouse Electric Corp., St. Louis, Mo.
March 12—Light Sources—Fluorescent, by R. R. Marvin, General Electric Co., North Kansas City, Mo.
March 19—Arithmetic of Lighting, by J. L. Krall, Sylvania Electric Products, Inc., Kansas City, Mo.
March 26—Industrial Lighting, by J. G. McDonald, Graybar Electric Co., Inc., Kansas City, Mo.
April 2—Office and School Lighting, by C. W. Thorsell, Tom Fielder Co., Kansas City, Mo.
April 9—Store Lighting, by F. P. O'Connor, St. Joseph Light and Power Co., St. Joseph, Mo.
April 16—Promoting Quality Lighting and Lighting Economics, by H. B. Ewert, Curtis Lighting, Inc., Kansas City, Mo.
April 23—Open Forum, by Faculty.

Classes are being held at the Lighting Institute, Kansas City Power and Light Co., Kansas City, Mo. Tuition fee is $5.00, with texts supplied.

STREET LIGHTING CLINIC, held in Cleveland, attracted police chiefs and representatives of city governments from Ohio, Michigan and Illinois. Shown here are, left to right across the page: H. W. Hoyt, chief of police, Kalamazoo, Mich.; L. M. Johnson, commissioner of streets and electricity, Chicago; H. V. Ryder, supervisor of street lighting, Philadelphia Electric Co.; William A. Porterfield, vice-president, Union Metal Mfg. Co., Canton, Ohio; Dana Rowten, Westinghouse Electric Co. and Cleveland Section Chairman; E. C. Powers, National Street and Traffic Safety Lighting Bureau; Cleveland; and David M. Baldwin, director of the traffic division, National Safety Council, Chicago.

Eastern Pa. Section Co-Sponsors Industrial Vision Conference

In cooperation with Wilkes College, Wilkes-Barrie, Pa., and the Northeastern Pennsylvania Optometric Society, the Eastern Pennsylvania Section, I.E.S. sponsored a full-day Conference on Industrial Vision, January 30.

With Mr. Stanley Young of Wilkes College presiding, the program opened with a welcome by Dr. Eugene Farley, President of the college. Papers presented were:

Efficient Vision as a Production Tool—Dr. Gustaf Streble, Visual Consultant, Eastman Kodak Co.
Modern Industrial Lighting Practice—E. A. Linsday, Lamp Division, General Electric Co.
Occupational Vision Tests and Testing—R. A. Sherman, Bausch & Lomb Co.
Eye Protection Practices in Industry—H. Walker Peters, Occupational Vision Consultant, Bausch & Lomb Co.
Color in Industry—E. B. Nelson, Color Consultant, Barreled Sunlight Paint Co.
Results of an Occupational Vision Program—E. Erickson, M.D., Wyomissing Industries, Reading, Pa.
The Economics of Industrial Vision Program—Lowell Johnson, Assistant to Vice-President, American Home Products Co., Inc.
Summary and Closing of the Conference by members of the faculty of Wilkes College.

Network Analyzer to Be Installed In Franklin Institute Laboratory

Seven major power companies in Pennsylvania, New Jersey and Delaware have contracted with the Franklin Institute for the installation of an alternating current network analyzer in the Institute's industrial research laboratories.

The $400,000 analyzer will be installed in a specially-fitted room atop the Institute. It is actually a power system in miniature, with a typical scale factor of 1 to 100,000. Its circuits represent generators, transmission lines, transformers and loads, and the use of this computing device will help solve the many complex problems involved in maintaining and expanding power systems. The installation will be placed in operation in mid-1954.

The power companies cooperating in this installation are:

Atlantic City Electric Company
Delaware Power and Light Company
Jersey Central Power and Light Company
Metropolitan Edison Company
New Jersey Power and Light Company
Pennsylvania Electric Company
Philadelphia Electric Company

Shirt Sleeves Sessions of the Chicago Section Study Club prove a "good idea."

These Sections Had a Good Idea

Three or four "good ideas," unusual or especially successful local projects, undertaken by I.E.S. Sections and Chapters will be outlined here each month. —ED.

1. **New England Section** data sheet reporter Norm Falk, published an appeal for his program on a recent notice mailed to all New England members. Says he, in effect, the Section has 400 members but only a handful of data sheet submissions. Further, he said, if their lighting jobs did not make an official data sheet, they might be pleasantly surprised to see it turn up in another form in ILLUMINATING ENGINEERING some month. Very true.

2. **Chicago Section** Study Club, under Dan Dunne, Chairman, has taken a new approach with results indicating it was a good idea. "Shirt sleeve" sessions, they're called, and so they are literally. Subjects discussed tie in closely with the regular Section meeting program which follows later in the evening. The sessions are conducted on the open forum technique with moderator and panel of experts rather than formal talks, more or less on the same pattern as top management discussions. The second such shirt sleeve session, and all subsequent meetings, found standing room only for latecomers. Such was their popularity.

3. **Ohio Valley Section** puts out a one-page mimeographed "newspaper," *The Informant*, to keep their members informed on local doings. One issue, for example, carries news on their Section's status in the membership contest, a report on the last meeting and a reminder for the next one.

4. **Twin City Section** conducted a Lighting Industry Panel recently which featured a representative from every branch of the industry. Panel participants included a consulting engineer, architect, contractor, jobber, fixture manufacturer, lamp company and a power company with a moderator keeping everything moving. Members found this a most educational and stimulating program.

Industrial Safety Stressed At Fundamentals Course

The 1953 sessions of the National Safety Council's Safety Training Institute opened with a five-day course on the "Fundamentals of Industrial Safety," held February 16-20.

The basic course, designed to help men presently engaged in industrial accident prevention gain a better understanding of occupational safety principles and methods, will be offered six times during the year.

During the six years the course has been offered by the Council, some 1,000 safety men from all over the world have attended its sessions. Instructors for the course are specialists drawn from the Council's staff.

I.E.S. National Technical Conferences

September 14-18, 1953—Hotel Commodore, New York
September 12-16, 1954—Chalfonte-Haddon Hall, Atlantic City
September 2-16, 1955—Statler Hotel, Cleveland
September 16-21, 1956—Statler Hotel, Boston.

Industrial Lighting Clinic To Be Held in Chicago

A clinic on Industrial Lighting, co-sponsored by the Chicago Section, I.E.S., and the Chicago Lighting Institute is planned for May 8. The proposed program is as follows:

MORNING SESSION—Carl W. Zerson, Manager, Chicago Lighting Institute, presiding

Good Factory Lighting is Common Sense—E. J. Fitzgerald, Superintendent, E. I. DuPont de Nemours, East Chicago, Indiana

Basic Facts about Industrial Lighting—W. D. Richards, Lighting Engineer, Chicago Lighting Institute

Lamps for Industry—Sam Easton, District Engineer, Sylvania Electric Products, Inc., Chicago

Lighting the Industrial Office—John W. Peterson, Manager of Lighting Sales, Graybar Electric Co., Inc., Chicago

Preventing Thrombosis in Current Carrying Arteries—Marshall A. Havenhill, Director, Lighting Institute, Kansas City, Mo.

AFTERNOON SESSION—Hoyt P. Steele, Vice-President, Benjamin Electric Manufacturing Co., presiding

Lighting the Industrial Plant—panel discussion, Glenn G. Boyd, Public Service Co. of Northern Illinois, Joliet, Ill., Moderator. Panel: B. S. Benson, Benjamin Electric Mfg. Co.; R. J. Diefenthaler, General Electric Co.; E. E. Elliott, Hawkins Electric Co.; Carl Lindell, Appleton Electric Co.; John McLaughlin, Kelso-Burnett Electric Co.; James Weeks, Westinghouse Electric Corp. Topic covered: general area lighting, high-bay area lighting, inspection lighting, special applications.

Trends in Industrial Lighting—H. P. Steele, Vice-President, Benjamin Electric Manufacturing Co.

EVENING SESSION

Revisions in National Electric Code as They Affect Lighting—speaker to be announced.

Industry's Interest in Good Lighting—panel discussion, Burr Martin, Publisher, *Electrified Industry*, Moderator. Panel: John W. Young, Supervisor of Safety, International Harvester Co.; Edward K. Taylor, Safety Director, Zenith Radio Corp.

The clinic will be held at the Chicago Lighting Institute, 37 South Wabash Ave.

I.E.S. Regional Conferences, 1953

Canadian	Chateau Laurier Ottawa, Ont.	March 23-24
Pacific Northwest	Hotel Benson Portland, Ore.	April 2-3
South Pacific Coast	Los Angeles, Calif.	April 9-10
Southwestern	Hotel Baker Dallas, Tex.	April 12-14
Midwestern	Radisson Hotel Minneapolis, Minn.	April 30 - May 1
East Central	Hotel Lord Baltimore Baltimore, Md.	May 14-15
Southern	Sedgefield Inn Greensboro, N. C.	May 18-19
Great Lakes	Syracuse Hotel Syracuse, N. Y.	May 25-26

Program—Canadian Regional Conference
March 23 and 24—Chateau Laurier, Ottawa, Ontario

March 23—Morning

Radio Interference—C. F. Patenson, Assistant Research Officer, National Research Council, Ottawa, Ont.

Testing and Certification of Luminaires—T. J. Brant, Supervising Engineer, Approval Laboratories Division, Canadian Standards Association, Toronto, Ont.

Afternoon

"My Most Interesting Lighting Job" Contest

Street and Highway Lighting—W. F. B. Debenham, Exterior Lighting Dept., General Electric Co., Ltd., London, England.

Blackout Lighting—Allan H. Owen, Manager, Manchester Branch of Cryselco Ltd., Manchester, England. (Mr. Owen has worked in collaboration with Mr. J. S. Smyth, Chief Lighting Engineer, General Electric Co., London.

March 24—Morning

Modern Hospital Lighting—D. W. Heywood, McDougall & Friedman, Montreal, Que.

The Influence of Modern Illumination on Architecture—W. A. Ramsay, Chief Architect, Air Service Branch, Department of Transport, Ottawa, Ont.

Airdrome Lighting—L. C. Simpson, Vice-President, American Gas Accumulator Co., Washington, D. C.

Luncheon—Speaker: Air Vice Marshal H. B. Godwin, Air Officer Commanding, Air Material Command, Ottawa, Ont.

Afternoon

Let's Understand Each Other—S. G. Hibben, Director of Applied Lighting, Westinghouse Electric Corp., Bloomfield, N. J.

Lighting for Defence and Production—R. P. Lindsay, Street Lighting Engineer, Canadian Line Materials, Ltd., Toronto, Ont.

Gloss Measurement Symposium Feature of A.S.T.M. Meeting

One technical feature of the 1953 Spring Meeting of the American Society for Testing Materials was a Symposium on Gloss Measurement. Held at the Hotel Statler in Detroit, March 4, the symposium was sponsored by the A.S.T.M. Committee E-12 on Appearance.

Two papers were presented at the morning session: "Surfaces as Seen and Photographed," and "The Physics of Surface Reflection." The afternoon session opened with a paper "Gloss and Its Measurement" with the balance of the time being devoted to discussion. Deane B. Judd, National Bureau of Standards, presided and summarized the day's activities at the close of the session.

Cash Prizes Awarded at Toronto Young Members Night

The Toronto Section, I.E.S., held their annual Young Members' Night, February 2, in the Electrical Building at the University of Toronto. There were four speakers, all under 35, competing for two ten dollar prizes. The prize for the best orator is donated by the Crouse-Hinds Co., and that for the best technical presentation by John C. Virden Co.

Winner of the oratory prize was Norman Bethune, Canadian General Electric Co., speaking on "A Standard Approach to Lighting Maintenance Problems." Miss Marion Currie, Ontario Hydro-Electric Power Commission Testing Laboratory, won the prize for the best technical presentation. Her subject was barrier-

layer cells used in light meters, and her talk was illustrated with graphs.

The other two speakers were Jack Townsend, Toronto Transportation Commission, speaking on "Lighting of Canada's First Subway!" and Doug Fielding, Peerless Electric Co., who discussed Mercury Vapor Lighting for Industry."

Attendance was approximately 55.

Armed Service Members Receive IE

A large percentage of I.E.S. members who are now in the armed services have taken the Society up on its offer to send copies of ILLUMINATING ENGINEERING, free, to their service addresses. (See I.E., December 1952, p. 7A). The armed service members, in their letters to headquarters, indicated great value was attached to regular receipt of I.E., as a means of keeping abreast of developments in the lighting industry.

H. Herbert Magdsick Retires, Past-President of I.E.S.

H. Herbert Magdsick, one of the Society's most continuously active Members, and past-national President, retired from business February 1. Mr. Magdsick's retirement follows more than 42 years continuous service with the General Electric Co., where he was for the past 23 years, executive engineer in the Application Engineering Department, Nela Park.

H. H. Magdsick

A Fellow of the Illuminating Engineering Society, and a member for 42 years, Mr. Magdsick was elected president in 1929. Last year he was awarded the Society's highest honor, the I.E.S. Gold Medal, for "distinguished contributions conspicuously furthering the art, knowledge, and profession, of illuminating engineering." He has made many valuable contributions to the work of the Illuminating Engineering Society serving as chairman of numerous technical committees and in the development of the Society's highest honor, the I.E.S. Gold program. In his retirement he will continue to serve I.E.S. as Chairman of the Committee on Lighting Education.

For nearly 25 years Mr. Magdsick has been a member of the United States National Committee of the International Commission on Illumination. He will continue to serve in several phases of the International Commission's activities.

Through noteworthy contributions Mr. Magdsick early became widely known in engineering and lighting circles throughout the United States and abroad. With the advent of the gas filled tungsten filament lamp in 1914 he designed many pioneer floodlighting installations. In 1923 he conducted the first International Lighting Mission, giving representatives of several European and South American countries an opportunity for an extended study of American lighting activities, and in the same year assisted in organizing lighting education centers in Europe.

He has fostered numerous basic studies establishing the fundamentals for a wide variety of applications of visible, infrared and ultraviolet radiation. He has been notably successful in the selection and training of men for the lighting field.

Mr. Magdsick has represented his company in connection with its sponsorship of the all-expense General Electric Science Fellowships at Case Institute of Technology, under which a total of 300 physics teachers in secondary schools have studied during the past six summers. He resides at 15724 Brewster Road, East Cleveland.

ABOUT PEOPLE

Dr. A. F. Dickerson, who retired last summer as manager of the Lighting and Rectifier Department of the General Electric Company, Lynn, Mass., was elected a Member Emeritus of I.E.S. by unanimous action of Council at its meeting February 12.

Also honored with Member Emeritus grade was **Chester L. Dows,** who retired recently after almost 40 years as a physicist with General Electric's Lamp Division, Nela Park.

Lester C. Twichell, Vice-President of the I.E.S. Great Lakes Region, is now Assistant Manager of the Commercial and Industrial Sales Department, Rochester Gas and Electric Corp.

Jesse T. Caldwell has been named assistant to **C. A. Conklin,** manager of the Central District of Westinghouse Electric Corp., in Pittsburgh. Mr. Caldwell was formerly manager of the company's Louisville branch and is succeeded by **Carl B. Connell.**

Walter J. Lind, Regional V-P of the I.E.S. North Pacific Coast Region, has been named District Manager of the Lamp Division of the Canadian General Electric Co., Ltd., in Vancouver, B. C.

Be It Resolved

that the National Council of the Illuminating Engineering Society record its sorrow at the passing on December 24 of our Member Emeritus, Clarence L. Law, President of the Society 1923-1924.

Active from 1908 in the formative years of the newly founded Society, Mr. Law served as an officer of the New York Section and later in the national offices of Director, General Secretary and Vice-President.

From 1906 associated with the Consolidated Edison Company in New York and from 1939 until his retirement in 1950 Vice-President in charge of the important area of company public relations.

Notable for his early leadership in the dissemination of lighting knowledge, firmly establishing illuminating engineering as an essential part of the work of the electrical utilities.

Responsible leader in many industry and civic organizations including the Electrical and Gas Association of New York.

Intensely interested in people both collectively and individually, his loss will be deeply felt by a great host of his true friends.

World's Largest Airport Terminal Building Features GARCY Custom-Designed Fixtures and New Lighting Application Techniques

Design of the Terminal Building was by Theodore Eichholz (deceased), under the guidance of Allegheny County Department of Aviation with the capable supervision of Director John B. Sweeney and Chief Engineer Edward G. Messner and with the assistance of Consulting Architect Joseph Hoover. James Paul Warner, consulting electrical engineer, is responsible for the airport's entire electrical system. The lighting facilities for this project were installed by Daniels Electric Equipment Co. and The Howard P. Foley Co. The distributor was Graybar Electric Co., Inc.

The unusual fixture which occupies the center of the rotunda ceiling is an adaptation of Garcy's No. 8440 Louverall. Note the customized treatment of the louverall area . . . conforming to the converging lines of the building which forms the segment of a circle. A wide variety of other Garcy stock and custom-design fixtures were utilized to meet the unusual architectural and lighting requirements involved. No matter how complex or unique your lighting problems may be, your nearby Garcy Representative can help you solve them efficiently, satisfactorily, economically.

UPPER RIGHT

View of Rotunda showing specially designed louverall area conforming to radial design of building. Continuously mounted troffers also follow this design.

LOWER RIGHT

View of South Dock showing variety of Garcy lighting equipment used in project. Modular and continuous louverall sections are shown at left, while individually mounted louvered aluminum troffers are used in center. Cove lighting is provided by Garcy Adda-Strip.

GARCY

Write for copy of new Garcy Lighting Equipment Catalog

GARDEN CITY PLATING & MFG. CO. 1760 N. Ashland—Chicago 22, Illinois

The 1952 Edison Medal has been awarded to **Dr. V. K. Zworykin**, pioneer researcher in electronics, by the American Institute of Electrical Engineers. The award, "for outstanding contribution to the concept and design of electronic components and systems," was presented at the opening session of the Institute's Winter General Meeting in New York City, January 19.

L. Melvin Grawemeyer has been elected Vice-President in Charge of Sales of the Illuminating Division of the Miller Company, Meriden, Conn. He was formerly the division's sales manager.

Bruce Todd, president of the Fluorescent Lighting Association, has resigned from the Swedish Iron and Steel Corp. to become an executive with the Illuminating Engineering Company, Detroit, Mich.

Charles Brady, Jr., of Sylvania Electric Products' Los Angeles office, has been transferred to Wheeling, W. Va., as sales manager. He is replaced by **R. C. Harper**, formerly district sales manager of the Central Pacific Region, San Francisco, who is, in turn, replaced by **W. L. Friend**.

Joseph Meratchnik has been appointed to the administrative staff of the Lamp Division, Westinghouse Electric Corp. Mr. Meratchnik will succeed **George E. Lambert** who recently was named manager of the division's plant at Fairmont, W. Va.

Robert L. Peloquin, sales promotion manager in the Chicago office of Westinghouse Lamp Division for the past three years, has been appointed manager of the newly expanded Indianapolis, Ind., division. **Robert J. Arnold**, who has been with the Lamp Division for more than 30 years, has been named special representative for the national accounts in the new territory, which includes all of Indiana and part of Michigan.

P. M. Rutherford, has been appointed Commercial Manager of the Dallas Power and Light Company. Mr. Rutherford was formerly Sales Promotion Manager for the same company.

OBITUARY

The Society hears with regret of the recent death of **Atilio Celis**, an active member who was instrumental in the formation of the Mexico Chapter, I.E.S., in 1950. Mr. Celis had been with International General Electric Company in San Juan, P.R. and Manila, P.I. as manager in charge of all lighting activities. Later he was transferred to the Schenectady office where he was lighting specialist with sales promotion duties for all countries except the United States and Canada.

In 1937, Mr. Celis was appointed Vice-President of the Mexican General Electric Company and joined the I.E.S. as a full member. He served as Local Representative for the Society in Mexico City, where he was also President of the Mexican Lighting Institute.

IT SEEMS TO ME

Lighting Terminology

May I add a fourth cheer to the three which, I know, have already been given by some illuminating engineers to Howard M. Sharp's statements about terminology commonly used in reference to light?

For any who missed it, Mr. Sharp wrote in part:* "Light is energy and energy exists only in pure form. There is no artificial energy (therefore no 'artificial' light) . . . Continued use of the term only adds to the difficulties of the engineer in his work with the public . . . Daylight is not 'natural' . . ." in the sense of good or normal. Mr. Sharp points out that daylight can have all the unfavorable attributes commonly attributed to "artificial" light.

For a good many years my work in the field of lighting has been largely with that "public" mentioned by Mr. Sharp. There are certain things which must be explained over and over; brightness is an example, since to the public it means intensity, amount, quantity, how much.

But A. F. Wakefield, former president of the Society, pointed out to me several years ago that there are two main sources of light—"daylight" and "electrical"—which are self-explanatory, and therefore preferable above any others. I seem to hear his voice in the Sharp cheering section. DEAC MARTIN, *Unique Services, Cleveland, Ohio.*

*Sharp, Howard, "Introduction to Lighting," Prentice-Hall, Inc., New York, 1951. Chap. 3.

NEW MEMBERS

At the meeting of the I.E.S. Council held in New York, N.Y. February 12, 1953, the following were elected to membership.

ALAMO CHAPTER

Member:
Rhine, G. R., George Rhine & Co., San Antonio, Texas.

Associate Members:
Braunschweig, A., Brownie Industrial Electric Co., San Antonio, Texas.
DeHart, J. M., Jimmie DeHart Electric Co., San Antonio, Texas.
Emig, R. E., General Electric Co., Corpus Christi, Texas.
Ewaldt, Jack, Corpus Christi Hardware Co., Corpus Christi, Texas.
Gryder, R. C., Geo. E. Anderson Co., Dallas, Texas.
Kessler, E. L., Southern Electric Supply Co., San Antonio, Texas.
Meehleib, W. E., Scott Electric Co., Corpus Christi, Texas.
Swanson, J. A. Jr., Westinghouse Electric Corp., Corpus Christi, Texas.
Telotte, T. C. Jr., Telotte Electric Co., San Antonio, Texas.

ARIZONA CHAPTER

Associate Members:
Hulse, R. R., Arizona Public Service Co., Phoenix, Ariz.
Jones, Bevan, Jr., Arizona Public Service Co., Phoenix, Ariz.
Kiedaisch, Jack, Arizona Public Service Co., Phoenix, Ariz.
Quinsler, W. T., Arizona Public Service Co., Phoenix, Ariz.
White, M. W., Arizona Public Service Co., Phoenix, Ariz.

CAPITAL SECTION

Member:
Carr, P. L., Godwin Holstead Electric Co., Charlottesville, Va.

CAROLINAS SECTION

Associate Members:
Efron, Marvin, Edgefield Hotel Bldg., Edgefield, S. C.
Johnston, J. W., Westinghouse Electric Corp., Charlotte, N. C.
Rehm, E. O., White Electrical Construction Co., Greensboro, N. C.

CENTRAL ILLINOIS CHAPTER

Associate Member:
Fahey, J. R., 217 Commercial National Bank Bldg., Peoria, Ill.

CENTRAL NEW YORK SECTION

Member:
Thompson, C. A., Cornell University, Ithaca, N. Y.

CHICAGO SECTION

Associate Members:
Chaput, J. F., Board of Education, Chicago, Ill.
Doupe, Ray, Luminous Ceilings Inc., Chicago, Ill.
Gill, W. T., Martin & A. Moffet Elec. Co., Chicago, Ill.
Grennan, R. L., Public Service Co. of No. Illinois, Glencoe, Ill.
Hawk, G. D., Public Service Co. of No. Illinois, Maywood, Ill.
Henzler, G. W., Public Service Co. of No. Illinois, Maywood, Ill.
Hill, H. L., Public Service Co. of No. Illinois, Maywood, Ill.
Pekara, Gus, Jr., Canning Pekara Inc., Chicago, Ill.
Sandquist, Oliver, 49 E. Oak St., Chicago, Ill.

Student Member:
Jasin, J. J. Jr., Marquette University, Milwaukee, Wis.

CLEVELAND SECTION

Member:
Allen, C. J., General Electric Co., Cleveland, Ohio.

Associate Members:
Brun, Johnny, Westinghouse Electric Corp., Cleveland, Ohio.
Masters, R. H., The Ohio Power Co., Canton, Ohio.

(Continued, col. 1, page 35A)

Supt. Frank D. Lawler, whose School Building Committee insisted on the most comfortable lighting, reports . . . . . .

. . "We wanted the best lighting available so we installed Westinghouse CD Luminaires"

"When we built the new Mary P. Hinsdale School, our School Building Committee insisted on the best and most comfortable lighting available. Westinghouse CD's have certainly lived up to those expectations," reports Superintendent Frank D. Lawler, Town of Winchester, Winsted, Conn.

The Westinghouse CD luminaire, with plastic shielding, provides a semi-indirect lighting system. Installed in continuous rows, as is shown in this classroom, the result is an almost glareless system of comfortable lighting. The entire ceiling becomes a part of the lighting system; all lamps are completely shielded.

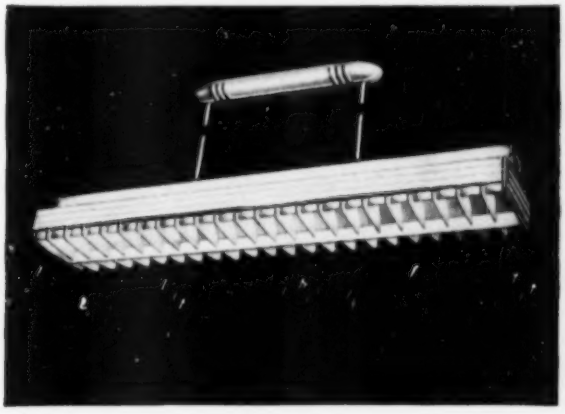
What's more, the Westinghouse CD makes an attractive addition to the classroom. Its design simplicity fits as a natural part of the background in modern interiors.

The superintendent further reports, "Our teachers and the school board are very pleased with the new lighting system. Their enthusiasm and that of our parents will undoubtedly influence both future construction and any remodeling of present classrooms."

This is one of the best, but not the only method of lighting classrooms. Westinghouse has a complete line of fluorescent and incandescent luminaires which meet modern classroom requirements. For any analysis of these methods, get B-4556, The ABC Plan for School Lighting, Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-04340

And to meet other requirements . . .

Low FIRST cost Concentric Ring incandescent luminaires meet quality lighting requirements on limited funds. Metal rings shield silvered bowl lamps, eliminating glare and shadows.



CC Luminaires mean economy in fluorescent lighting. Low in initial cost—low in maintained cost. CC with X° louver design meets A.S.A. school standards.

YOU CAN BE SURE . . . IF IT'S Westinghouse

I. E. S. National and Local Officers—1952-1953

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President — EVERETT M. STRONG, Cornell University, Ithaca, N. Y.

Vice-President — A. H. MANWARING, Philadelphia Electrical & Mfg. Co., 1228 N. 31st St., Philadelphia 21, Pa.

Vice-President — DUNCAN M. JONES, Curtis Lighting Co. of Canada, Ltd., Montreal, Que.

Past-President — S. G. HIBBEN, Westinghouse Electric Corp., Bloomfield, N. J.

Past-President — WALTER STURROCK, General Electric Co., Nela Park, Cleveland, Ohio.

General Secretary — C. C. KELLER, Holophane Co., Inc., 342 Madison Ave., New York, N. Y.

Treasurer — KIRK M. REID, General Electric Co., Cleveland 12, Ohio.

Directors

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J. S. SCHUCHERT, Duquesne Light Co., Pittsburgh, Pa.

J. F. WHITEHEAD, JR., Day-Brite Lighting Corp., St. Louis, Mo.

F. C. WINKLER, Westinghouse Electric Corp., Cleveland, Ohio.

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East Central Region — PAUL H. HILDEBRAND, Pennsylvania Power & Light Co., Allentown, Pa.

Great Lakes Region — L. C. TWICHELL, Rochester Gas & Electric Corp., Rochester, N. Y.

Inter-Mountain Region — HAROLD T. RANKIN, Public Service Co. of Colorado, Denver, Colo.

Midwestern Region — L. B. PAIST, Northern States Power Co., Minneapolis, Minn.

Northeastern Region — GEORGE J. TAYLOR, Day-Brite Lighting Inc., New York, N. Y.

Pacific Northwest Region—WALTER J. LIND, Canadian General Electric Co., Ltd., Vancouver, B. C.

Southern Region — R. CECIL PASLAY, Louisiana Power & Light Co., New Orleans, La.

South Pacific Coast Region — L. A. HOBBS, Smoot Holman Company, Inglewood, Calif.

Southwestern Region — W. E. FOLSOM, Dallas Power & Light Company, Dallas, Texas.

Section and Chapter Officers 1952-1953

Alabama Chapter — Southern Region

Chairman—WALTON T. REEVES, Moore Handley Hardware Co., Inc., 27 S. 20th Street, Birmingham 2, Ala.

Secretary—ALOYS S. SHOOK, General Electric Co., 724 Comer Bldg., Birmingham 3, Ala.

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Chairman — E. S. RICHARDSON, Electrical Distributing Co., 102 W. Josephine St., San Antonio, Texas.

Secretary — FLOYD A. COVINGTON, JR., Floyd A. Covington Co., 130 Adrian St., San Antonio, Texas.

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Secretary — D. S. GORDON, British Columbia Electric Railway Co. Ltd., 570 Dunsmuir St., Vancouver, B. C.

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Chairman—C. G. ESTABROOK, Anderson & Estabrook, Inc., 1021 N. Fillmore St., Arlington 1, Va.

Secretary — DOROTHY NICKERSON, U. S. Dept. of Agriculture, Cotton Branch, Washington 25, D. C.

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Chairman — HAMILTON COREY, Graybar Electric Co., Inc., 120 W. Morehead St., Charlotte 1, N. C.

Secretary — G. E. WILKINSON, P. O. Box 1339, Charlotte 1, N. C.

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Chairman — R. H. RAHE, Westinghouse Electric Supply Co., 1800 N. Adams St., Peoria, Ill.

Secretary—J. W. REGAN—St. Francis Hospital, Peoria, Ill.

Central New York Section — Great Lakes Region

Chairman — WARREN H. LAWRENCE, Gould Farmer Co. Inc., 1020 W. Genesee St., Syracuse 1, N. Y.

Secretary — ROBERT H. GOODMAN, Crouse-Hinds Co., Wolf & 7th North Sts., Syracuse 1, N. Y.

Chicago Section — Midwestern Region

Chairman — WILLIAM A. WEIBEL, Curtis Lighting Inc., 6135 W. 65th St., Chicago 38, Ill.

Secretary — ARTHUR P. LARSON, Commonwealth Edison Co., 2233 S. Throop St., Chicago 8, Ill.

Cleveland Section — Great Lakes Region

Chairman — D. W. ROWTEN, Westinghouse Electric Corp., 1216 W. 58th St., Cleveland, Ohio.

Secretary — ROBERT MORRIS, General Electric Co., Nela Park, Cleveland 12, Ohio.

Connecticut Section — Northeastern Region

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Secretary — RAYMOND O. MILLS, Connecticut Light & Power Co., Leavenworth & Center Sts., Waterbury, Conn.

Cornhusker Chapter — Midwestern Region

Chairman — E. E. SCHWALM, Omaha Public Power District, Omaha, Nebr.

Secretary — R. W. GIBB, Omaha Public Power District, Omaha, Nebr.

Eastern New York Chapter — Northeastern Region

Chairman — C. E. WALDRON, Niagara Mohawk Power Corp., 126 State St., Albany, N. Y.

Secretary — MATTHEW J. VITARTAS, Westinghouse Electric Corp., 456 W. Peal St., Albany, N. Y.

Eastern Pennsylvania Section — East Central Region

Chairman — E. W. HALTEMAN, Pennsylvania Power & Light Co., 534 Main St., Bethlehem, Pa.

Secretary — P. A. KINSEY, Metropolitan Edison Co., 412 Washington St., Reading, Pa.

Florida Chapter — Southern Region

Chairman—C. E. McCORMICK, 2910 Villa Rosa Park, Tampa, Florida.

Secretary — FRANK A. WOODHEAD, 4606 Fairway Drive, Tampa, Florida.

Georgia Section — Southern Region

Chairman—J. DIXON MITCHELL, JR., Westinghouse Electric Corp., 2260 Peachtree Industrial Blvd., Chamblee, Ga.

Secretary — J. E. McCOMACK, 129 Interlocken Dr. N. W., Atlanta, Ga.

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Chairman — D. F. DAVIS, Northern Electric Co. Ltd., 157 Main St., E. Hamilton, Ont.

Secretary — F. W. NEW, Walker and Associates Ltd., 162 King William St., Hamilton, Ont.

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Chairman—WILLARD L. STIERS, 4309 W. 71st St., Prairie Village 15, Kans.

Secretary — J. GORDON McDONALD, Graybar Electric Co. Inc., 1644 Baltimore, Kansas City, Mo.

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Chairman — SAM E. JENKINS, Allen & Kelley, 435 Architects & Builders Bldg., Indianapolis 4, Ind.

Secretary — RALPH CROCKETT, General Electric Co., 1115 Circle Tower, Indianapolis 4, Ind.

Inland Empire Chapter — Pacific Northwest Region

Chairman — W. A. NEWMAN, Washington Water Power Co., P.O. Drawer 1445, Spokane 10, Wash.

Secretary — GEORGE MORRISON, Washington Water Power Co., P.O. Drawer 1445, Spokane, Wash.

Iowa Section — Midwestern Region

Chairman — JAMES H. HULL, Day-Brite Lighting Inc., 1300 47th St., Des Moines, Ia.

Secretary — J. CHARLES YOUNG, JR., Iowa Electric Light & Power Co., Box 351, Cedar Rapids, Ia.

Maritime Chapter — Canadian Region

Chairman — J. C. NICKERSON, Northern Electric Co., Ltd., 599 Main St., Moncton, N. B.

Secretary — G. C. ROBINSON, Curtis Lighting of Canada, P.O. Box 1064, St. John, N. B.

Maryland Section — East Central Region

Chairman — EDMUND S. BARRINGTON, Westinghouse Electric Corp., 501 St. Paul Place, Baltimore 2, Md.

Secretary — GEORGE F. WALTER, General Electric Co., 1403 Court Square Bldg., Baltimore 2, Md.

Mexico Chapter

Chairman—ANTONIO CARBAJAL, Insurgentes 367, Mexico City 11, D. F., Mexico

Secretary—MANUEL SAENZ DE CAMARA, Illuminacion Planedada S. de R. L., Mexico City, Mexico

Michigan Section — Great Lakes Region

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how to get comfortable and effective lighting in a low ceiling room

THE SOLUTION:

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5. **It offers a selection of three levels of illumination without disturbing the relatively even brightness pattern of ceiling. 18 fluorescent lamps (72 inch T-12) are mounted above the Plexiglas diffusers. Combinations of lamps of two circuits permit the selection of three different levels of illumination: 8 lamps give 50 footcandles; 10 lamps give 65 footcandles; all 18 lamps give 115 footcandles. The single-lamp channels, using a standard cool white fluorescent lamp, are mounted 18 inches on centers above the Plexiglas. The ceiling height is eight feet, ten inches.**

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Secretary—FRED M. NIELL, P.O. Box 388, Memphis, Tenn.

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Chairman — E. H. SCHAEFER, Wisconsin Electric Power Co., 231 W. Michigan Ave., Milwaukee 3, Wis.

Secretary — HOWARD W. GROSH, Westinghouse Electric Corp., 538 N. Broadway, Milwaukee 2, Wis.

Mississippi Chapter — Southern Region

Chairman—A. N. SAXON, Graybar Electric Co., Jackson, Miss.

Secretary — H. Q. PRAY, Mississippi Power & Light Co., 144 S. Congress St., Jackson 5, Miss.

Montreal Section — Canadian Region

Chairman — R. S. TATE, Canadian General Electric Co. Ltd., 1000 Beaver Hall Hill, Montreal, Que.

Secretary—R. H. SMITH, T. H. Smith & Associates, 1247 Greene Avenue, Montreal Que.

Mother Lode Chapter — South Pacific Coast Region

Chairman — ANDREW LOUARGAND, Division of Architecture, State of California, 1725 23rd St., Sacramento, Calif.

Secretary — WILLIAM J. FLYNN, Sacramento Municipal Utility District, Sacramento, Calif.

New England Section—Northeastern Region

Chairman — L. S. COOKE, General Electric Co., 50 High St., Boston 10, Mass.

Secretary — H. R. FINNEY, Westinghouse Electric Corp., 10 High St., Boston, Mass.

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Chairman — STANLEY BAZANT, JR., Public Service Co. of New Mexico, 424 W. Central, Albuquerque, N. M.

Secretary—MRS. W. O. RHODES, P.O. Box 307, Los Alamos, N. M.

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Chairman — HARBERT S. GREGORY, Gregory & Salisbury, 335 No. Peters St., New Orleans, La.

Secretary—J. M. GENSBURGER, New Orleans Public Service, 317 Baronne St., New Orleans, La.

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Secretary — EUGENE M. FAHEY, Public Service Electric & Gas Co., 80 Park Place, Newark 1, N. J.

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Chairman — ROBERT W. THUNEN, Sylvania Electric Products Inc., 6450 Hollis St., Emeryville, Calif.

Secretary — JAMES E. BARNES, Pacific Gas & Electric Co., 4th & E. Streets, San Rafael, Calif.

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Chairman — H. CRESTON DONER, Libbey-Owens-Ford Glass Co., Nicholas Building, Toledo 3, Ohio.

Secretary — MARY E. DODDS, Toledo Edison Co., Edison Bldg., Toledo 4, Ohio.

Ohio Valley Section — Great Lakes Region

Chairman—R. J. SCHULTE, General Electric Co., 823 Gas & Electric Bldg., Dayton, Ohio.

Secretary — EDWARD J. McGINNIS, Cincinnati Electrical Association, 1107 Union Trust Bldg., Cincinnati 1, Ohio.

Oklahoma Chapter — Southwestern Region

Chairman — HAROLD F. MILLER, Sylvania Electric Products Inc., 2748 E. 4th St., Tulsa 4, Okla.

Secretary — DALE H. WATT, Watt Plumbing, Air Conditioning & Electric Co., 528 E. 5th St., Tulsa, Okla.

Oregon Section — Pacific Northwest Region

Chairman — RAY W. PRESTON, 804 Lewis Bldg., Portland 1, Oregon.

Secretary — MARION S. PRESTWOOD, JR., Portland General Electric Co., 621 S. W. Alder St., Portland 5, Oregon.

Ottawa Chapter — Canadian Region

Chairman — MAJOR G. D. MILLS, 283 Osborne Ave., Britannia Heights, Ottawa, Ont.

Secretary — W. E. RENY, Northern Electric Co., Ltd., 141 Catharine St., Ottawa, Ont.

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Chairman — T. W. LAUER, Rumsey Electric Co., 1007 Arch St., Philadelphia 7, Pa.

Secretary — F. R. ADAIR, Westinghouse Electric Corp., 3001 Walnut St., Philadelphia 4, Pa.

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Chairman — G. H. MAIZE, Duquesne Light Co., 435 6th Ave., Pittsburgh 19, Pa.

Secretary — H. D. SILER, Pittsburgh Reflector Co., 403 Oliver Bldg., Pittsburgh 22, Pa.

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Chairman — C. A. SCHEYER, Puget Sound Power & Light Co., 101 Electric Bldg., Seattle 11, Wash.

Secretary — G. D. KING, Sylvania Electric Products Inc., 3466 E. Maryland Way, Seattle, Wash.

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Secretary—J. D. THERIAULT, Quebec Power Company, 229 St. Joseph St., Quebec, P. Q.

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Chairman — N. T. KRIDEL, Rochester Gas & Electric Co., 89 East Ave., Rochester 4, N. Y.

Secretary — A. G. ELLEY, Rowe Electric Co., 255 East Ave., Rochester 4, N. Y.

Rocky Mountain Section — Inter-Mountain Region

Chairman — FERMAN BISCHOFBERGER, Public Service Co. of Colorado, 900 15th St., Denver 2, Colo.

Secretary — CARL W. STRAIN, General Electric Co., 1863 Wazee St., Denver 1, Colo.

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Chairman — LELAND M. WALLACE, JR., Westinghouse Electric Corp., 411 N. 7th St., St. Louis 1, Mo.

Secretary — GEORGE F. HEROLD, Harry F. Wilson, 4908 Delmar, St. Louis 8, Mo.

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Chairman — M. L. KENNARD, Gulf Coast Electric Supply Co. Inc., 3624 McKinney Ave., Houston 3, Texas.

Secretary — E. C. OBER, Marlin Associates, 3420 McKinney, Houston 3, Texas.

San Jose Chapter — South Pacific Coast Region

Chairman—WILLIAM ADDISON, Pacific Gas and Electric Co., 86 So. Third St., San Jose 14, Calif.

Secretary — VERNON H. LIND, Pacific Gas and Electric Co., 86 So. Third St., San Jose 14, Calif.

Southeast Florida Chapter—Southern Region

Chairman—W. F. HOLTSINGER, Box 157, Riverside Station, Miami, Fla.

Secretary—J. V. SHELLHORSE, JR., Florida Power & Light Co., 25 S. E. 2nd Avenue, Miami 30, Fla.

Southern California Section — South Pacific Coast Region

Chairman — ROY E. DAHLIN, Southern California Edison Co. Ltd., P.O. Box 351, Los Angeles 53, Calif.

Secretary — F. EDWIN BLAIR, 3705 Cartright St., Pasadena, Calif.

Southern Colorado Chapter — Inter-Mountain Region

Chairman — CHARLES D. BELL, Southern Colorado Power Co., 4th & Main Streets, Pueblo, Colo.

Secretary — CARL F. BALSICK, Pueblo Electric Supply Co., 131 Spring St., Pueblo, Colo.

Southwestern Section — Southwestern Region

Chairman—W. T. KIMERY, Dallas Power & Light Co., 1506 Commerce Street, Dallas 1, Texas

Secretary—MISS RUTH PATTERSON, Dallas Power & Light Co., 1506 Commerce Street, Dallas 1, Texas

Tennessee Valley Section — Southern Region

Chairman — JOE L. BOOKER, General Electric Supply, 128 Sixth Ave. So., Nashville, Tenn.

Secretary—WILLIAM H. RIDLEY, Nashville Electric Service, 1204 Church St., Nashville, Tenn.

Toronto Section — Canadian Region

Chairman — F. C. MAYBERRY, Canadian National Exhibition Association, Exhibition Grounds, Toronto 1, Ont.

Secretary — G. E. DAVIDSON, Hydro Electric Power Comm., 620 University Ave., Toronto, Ont.

Twin City Section — Midwestern Region

Chairman — DONALD P. GREENE, Larson & McLaren, 1901 Foshay Tower, Minneapolis 2, Minn.

Secretary—LAWRENCE E. JOHNSON, Northern States Power Co., 15 S. Fifth St., Minneapolis 2, Minn.

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Chairman—GEORGE SPURBECK, Minnesota Power & Light Co., 30 W. Superior, Duluth, Minn.

Secretary—OVIN HANKE, General Electric Company, 1010 Fidelity Bldg., Duluth 2, Minn.

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Chairman — LEONARD M. SLUSSER, 318 Dooly Bldg., Salt Lake City, Utah.

Secretary—DARCIE H. WHITE, Utah Power & Light Co., P. O. Box 899, Salt Lake City, Utah.

Vancouver Island Chapter — Pacific Northwest Region

Chairman—KENNETH REID, City Hall, Victoria, B. C., Canada.

Secretary — SIDNEY E. JARVIS, Electrical Service League of B. C., 1501 Douglas St., Victoria, B. C., Canada.

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Chairman — J. A. DEWINTER, J. & G. Daverman Co., 924 Grandville Avenue, S. W., Grand Rapids 9, Mich.

Secretary — RONALD C. LYON, Consumers Power Co., 153 S. Rose, Kalamazoo, Mich.

Western New York Section — Great Lakes Region

Chairman — WILLIAM A. BISER, General Electric Co., 535 Washington St., Buffalo 3, N. Y.

Secretary — JOHN B. GOTTARDI, Robertson Electric Co. Inc., 126 S. Elmwood Ave., Buffalo 1, N. Y.

Winnipeg Chapter — Canadian Region

Chairman — L. W. MACKENZIE, Canadian General Electric Co. Ltd., 265 Notre Dame St. Winnipeg, Man.

Secretary — E. J. COPLAND, F. D. Bolton Ltd., 401 Avenue Bldg., Winnipeg, Man.

COMMITTEES

COMMITTEES 1952-1953

All committees are appointed by the President, subject to approval of the Council and, except as provided in the Constitution, terminate at the time of the first Council meeting each administration, in the month of October. The scope of each committee is indicated.

E. M. Strong, President, ex officio member of all committees.

STANDING COMMITTEES

BOARD OF FELLOWS — To evaluate the eligibility of candidates for transfer to the grade of Fellow and recommend their election by Council.

E. F. Lowry, Chairman, Sylvania Electric Products Inc., 60 Boston St., Salem, Mass.

A. A. Brainerd	J. M. Ketch
Paul H. Goodell	**H. L. Logan**

G. F. Mudgett

COUNCIL EXECUTIVE — To conduct the affairs of the Society between Council meetings.

E. M. Strong, Chairman, Cornell University, Franklin Hall, Ithaca, New York

D. M. Jones	**A. H. Manwaring**
C. C. Keller	K. M. Reid

FINANCE — To direct supervision of the financial affairs of the Society, present annual report on its financial condition and make recommendations to Council as to investments of money and upon all specific appropriations.

M. S. Waterman, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

W. W. Booth — K. M. Reid, ex officio

G. J. Taylor

GENERAL BOARD OF EXAMINERS — Evaluate the eligibility of applicants for admission to membership or transfer to the grade of Member and submit to Council their nominees for elections to the grade of Member Emeritus.

Clifford Miller, Chairman, Consolidated Edison Co. of N. Y. Inc., 4 Irving Place, New York, N. Y.

T. O. Jergensen — **R. R. Wylie**

MEDAL AWARD — To consider qualifications of candidates for I.E.S. Medal; submit recommendations to Council and prepare citation for the award.

Howard L. Wright, Chairman, Curtis Lighting of Canada, Ltd., 195 Wicksteed Ave., Leaside-Toronto, Ont.

R. B. Brown, Jr.	S. G. Hibben
E. C. Crittenden	M. Luckiesh
C. H. Goddard	**C. O. Martin**
G. K. Hardacre	Walter Sturrock

PAPERS — To procure, review and approve all technical papers and discussions thereof, for presentation before National Conferences of the Society.

R. M. Zabel, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

L. E. Barbrow, Vice-Chairman, National Bureau of Standards, Washington, D. C.

L. J. Buttolph	C. N. Laupp
C. L. Cottrell	**W. P. Lowell, Jr.**
George Gilleard	**G. A. Trosper**
B. F. Greene	H. L. Wright

PUBLICATIONS — To be responsible for the procurement, review and approval of all material for the publications of the Society other than technical papers approved by the Papers Committee for presentation at National Conferences of the Society and their discussions and committee reports, for which it will have publication responsibility only. Shall also be responsible for the editing, printing and business management of the publications of the Society.

D. M. Jones, Chairman, Curtis Lighting Co. of Canada, Ltd., 991 St. Antoine St., Montreal, Quebec, Canada.

J. S. Schuchert — R. M. Zabel

Sub-Committee on Sales

J. S. Schuchert, Chairman, Duquesne Light Co., 435 Sixth Ave., Pittsburgh, Pa.

Sub-Committee on Editorial Content

R. M. Zabel, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

L. E. Barbrow, Vice-Chairman, National Bureau of Standards, Washington, D. C.

L. J. Buttolph	B. F. Greene
C. L. Cottrell	W. P. Lowell, Jr.
Hedley Davidson	G. A. Trosper
George Gilleard	H. L. Wright

Sub-Committee on Technical Data Sheets

Eric H. Church, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

G. T. Anderson	Eve Freyer
C. L. Crouch	Ruby Redford

Section and Chapter Representatives:

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G. T. Anderson, Jr.	Robert Jones
T. H. Bailey	Robert J. Kuzell
C. T. Bakeman	H. G. Locke
W. P. Beazley	Byron Lyth
M. E. Broom	J. B. McCracken
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L. V. Hadsell	Leigh Watkins III
T. R. Halsey	Dale H. Watt
W. F. Holtsinger	G. H. Wheatley
J. T. Hornsby	R. J. Welch
H. A. Hutchinson	T. J. Wood

Subcommittee on Home Lighting Data Sheets

Aileen Page, Chairman, General Electric Co., Nela Park, Cleveland, Ohio

Marion Amsbary	Emma Koch
Edith Buchholtz	Ruth Morris
Melrose Franklin	Jan Reynolds
Marie Gorman	Ruth Schmoll

Blanch Waggener

GENERAL COMMITTEES

ADVANCE PLANNING—To study the operation, program, publication activities, membership classifications and financial structure with a view of its immediate and long-range objectives and to make recommendations to Council.

C. C. Keller, Chairman, Holophane Co., Inc., 342 Madison Ave., New York, N. Y.

R. L. Biesele, Jr.	J. E. Mueller
C. H. Goddard	J. F. Whitehead, Jr.

ADVISORY BOARD ON COMMITTEE PERSONNEL — To examine the organization, accomplishments, and assignments of committees and prepare not later than June 1st of each year a proposed list of committees and personnel.

A. H. Manwaring, Chairman, Philadelphia Electrical & Mfg. Co., 1228 N. 31st St., Philadelphia, Pa.

C. L. Crouch	A. D. Hinckley
C. H. Goddard	D. M. Jones
S. G. Hibben	C. C. Keller

BOARD OF NOMINATION — To prepare a nomination ticket containing the names of those who are deemed best suited to serve as officers and directors in positions to be filled at the ensuing election.

C. H. Goddard, Chairman, Sylvania Electric Products Inc., 60 Boston St., Salem, Mass.

S. G. Hibben — Walter Sturrock

(With Section Representatives)

CONSTITUTION AND BY-LAWS — To prepare for Council amendments to the Constitution and By-Laws as required, and to develop rules of procedure for the operation of the Society.

Walter Sturrock, Chairman, General Electric Company, Nela Park, Cleveland, Ohio

G. W. Beals	Myrtle Fahsbender
G. F. Dean	G. K. Hardacre

COORDINATING COMMITTEE FOR DEFENSE— To contact various Government Agencies concerned with National Security suggesting cooperation and participation in specific projects as an aid to solution of their problems. Recommending the placement of lighting study projects in present committees or the appointment of study project committees to the Society President and to expedite such study projects and guide accepted reports into proper Government channels.

G. D. Mills, Co-Chairman, Department of National Defense, New Army Bldg., Ottawa, Ont.

A. F. Wakefield, Co-Chairman, The F. W. Wakefield Brass Co., Vermilion, Ohio

J. W. Bateman	S. L. Drumm
H. R. Blackwell	K. M. Reid
O. P. Cleaver	John S. Walsh
C. L. Crouch	M. N. Waterman

Sub-Committee on Artificial Moonlight Project

L. M. N. Bach, Chairman, Tulane University of Louisiana, P. O. Station 20, New Orleans, La.

J. A. Bartelt	Mason Guillory
H. R. Blackwell	Robert Long
S. Q. Duntley	C. J. Sperry

Task Committee #10—Wartime Conservation in Lighting Systems

C. E. Weits, Chairman, General Electric Company, Cleveland, Ohio.

HISTORICAL — To assemble and make available for current reference and to prepare in suitable and durable form for posterity, such historical facts, printed memorabilia, photographs, voice records, museum specimens and allied items as may be judged worthy of composing a continuing digest of the record of the Society's history.

S. G. Hibben, Chairman, Westinghouse Electric Corp., Bloomfield, N. J.

R. B. Burton, Sr.	L. H. Graves
Julius Daniels	V. Lansingh
Leo Dolkart	Mrs. W. F. Little

G. H. Stickney

LIGHTING SERVICE — To stimulate the discussion and practical application of lighting recommendations, standards, test procedures and other technical and scientific data developed by the Society to regional and local committees and to conduct a Lighting Service Forum in connection with the National Technical Conference.

L. E. Tayler, Chairman, Detroit Edison Company, 2000 Second Avenue, Detroit, Mich.

P. H. Hildebrand	J. S. Schuchert
R. A. Palmer	F. C. Winkler

LOCAL ACTIVITIES — To coordinate regional and local activities with the national program of the Society, assist Section and Chapter officers with local operating problems, conduct

(Continued on page 25A)

Tunnel lighting is now a science

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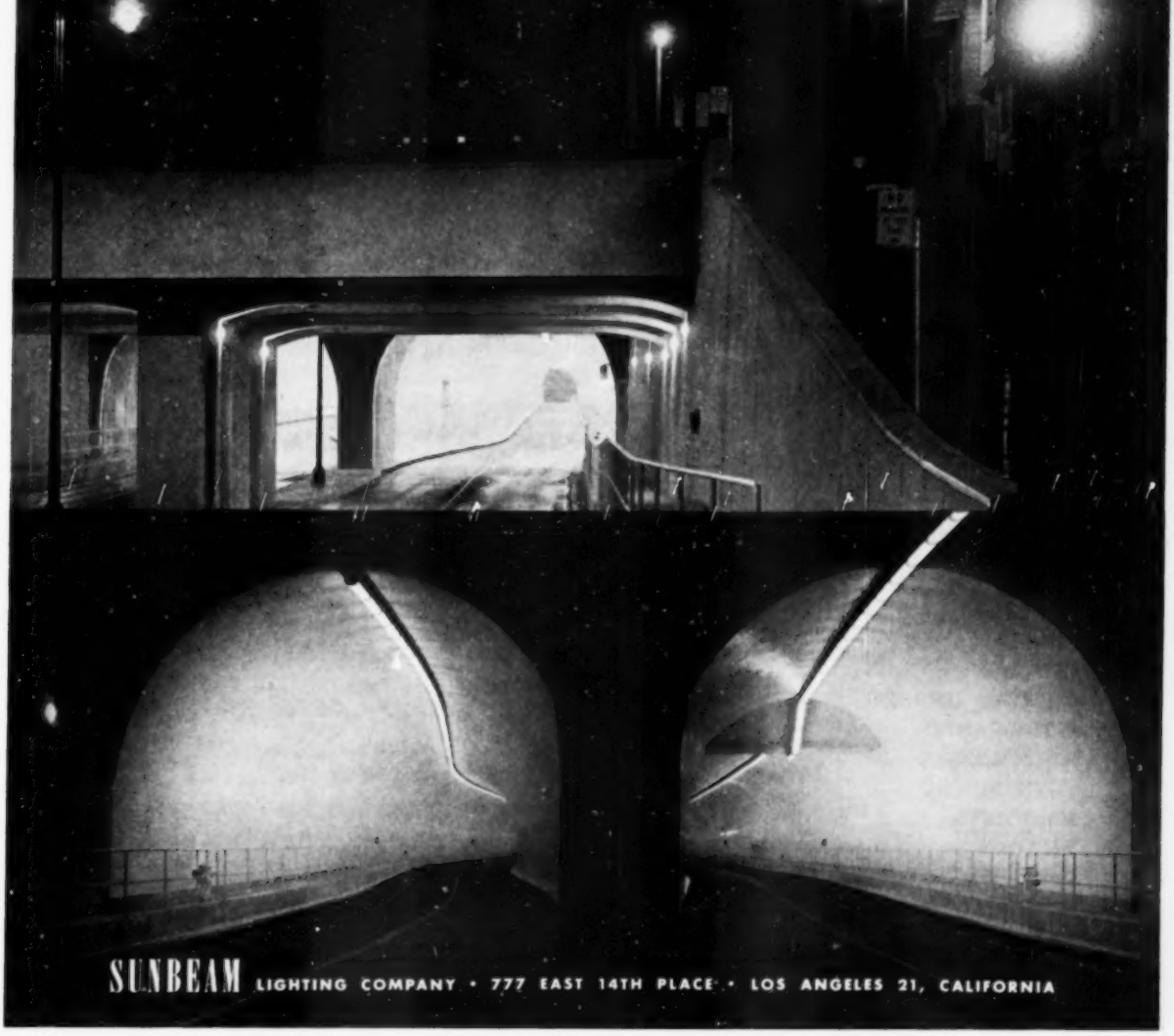

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(*Continued from page 22A*)

Local Activities Conferences, prepare plans to give members a better understanding of the Society, review applications for the establishment of new Sections and Chapters and recommend the appointment of local representatives.
Duncan M. Jones, Chairman, Curtis-Lighting Co. of Canada, Ltd., 991 St. Antoine St. Montreal, Quebec, Canada

W. E. Folsom	L. B. Paist
P. H. Hildebrand	R. C. Paslay
L. A. Hobbs	H. T. Rankin
F. P. Labey	G. J. Taylor
W. J. Lind	L. C. Twichell

MEMBERSHIP — To develop plans and supervise the operation of the individual membership campaign in the Society.
R. G. Slauer, Chairman, Sylvania Electric Products Inc., 60 Boston St., Salem, Mass.

Section and Chapter Representatives

George B. Almy	Henry Lushington
John M. Asher	R. W. Lyon
William Benndorf	Romeo Martineau
Frank Biallas	W. A. Mize
Stanley Blois	K. W. Moore
T. J. Bjorge	E. E. Norwood
Fred A. Brewer	W. F. C. Nottelman
H. Chippendale, Jr.	R. L. O'Donovan
Lloyd W. Crotser	Merrill Pearson
A. E. Danes	H. J. Poehling
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J. H. Ferguson	Arthur Principe
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Locke Goode	F. C. Scharr
Ewart M. Haacke	Charles Selby
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Hugh S. James	F. T. Tillemans
James R. Jones	William H. Tometich
Bernard A. Koller	A. D. Wallace
F. L. Knudsen	Larry Vaughn
W. A. Lampinen	D. Mack Woodside
Howard Long	H. Young

NATIONAL TECHNICAL CONFERENCE — To supervise the 1953 Technical Conference, select the time and place for the 1955 Technical Conference and act as a depository of invitations for future conferences; study and report to Council the possibility of holding periodically a nationally sponsored technical conference for the Pacific Coast Zone.
Hoyt P. Steele, Chairman, Benjamin Electric Mfg. Co., Des Plaines, Ill.

C. L. Amick	C. C. Keller
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PROCEDURES AND POLICIES — Analyze for Council current procedures and policies and make recommendations.
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SEARCHLIGHT—To study the design and application of searchlights and to report thereon.
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(*Continued on page 26A*)

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CIVIL DEFENSE, LIGHTING FOR — To appraise and report on special lighting problems connected with emergency military operations that directly involve civilian defense and protection, such as equipment for bomb shelters, special street and vehicular lighting, mobile self-contained lighting facilities for use in bombed areas, and emergency lighting devices and visual aids to movement in the event of power failure.
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ILLUMINATION PERFORMANCE RECOMMENDATIONS — To prepare illumination performance recommendations for luminaires conforming to I.C.I. classifications, excluding residential.
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LIGHT CONTROL AND EQUIPMENT DESIGN — Collect and correlate the knowledge and data on means and methods of controlling, directing, reflecting, transmitting and diffusing light and on the principles and practices of equipment design.
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LIGHTING EDUCATION — To prepare educational and training programs on the fundamentals of illumination, lighting design problems and advance theories of light and lighting application. To prepare required text material and to further their adoption locally.
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(Continued on page 28A)

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G. F. Dean, Vice-Chairman, Toronto Hydro-Electric System, 14 Carlton St., Toronto, Ont.

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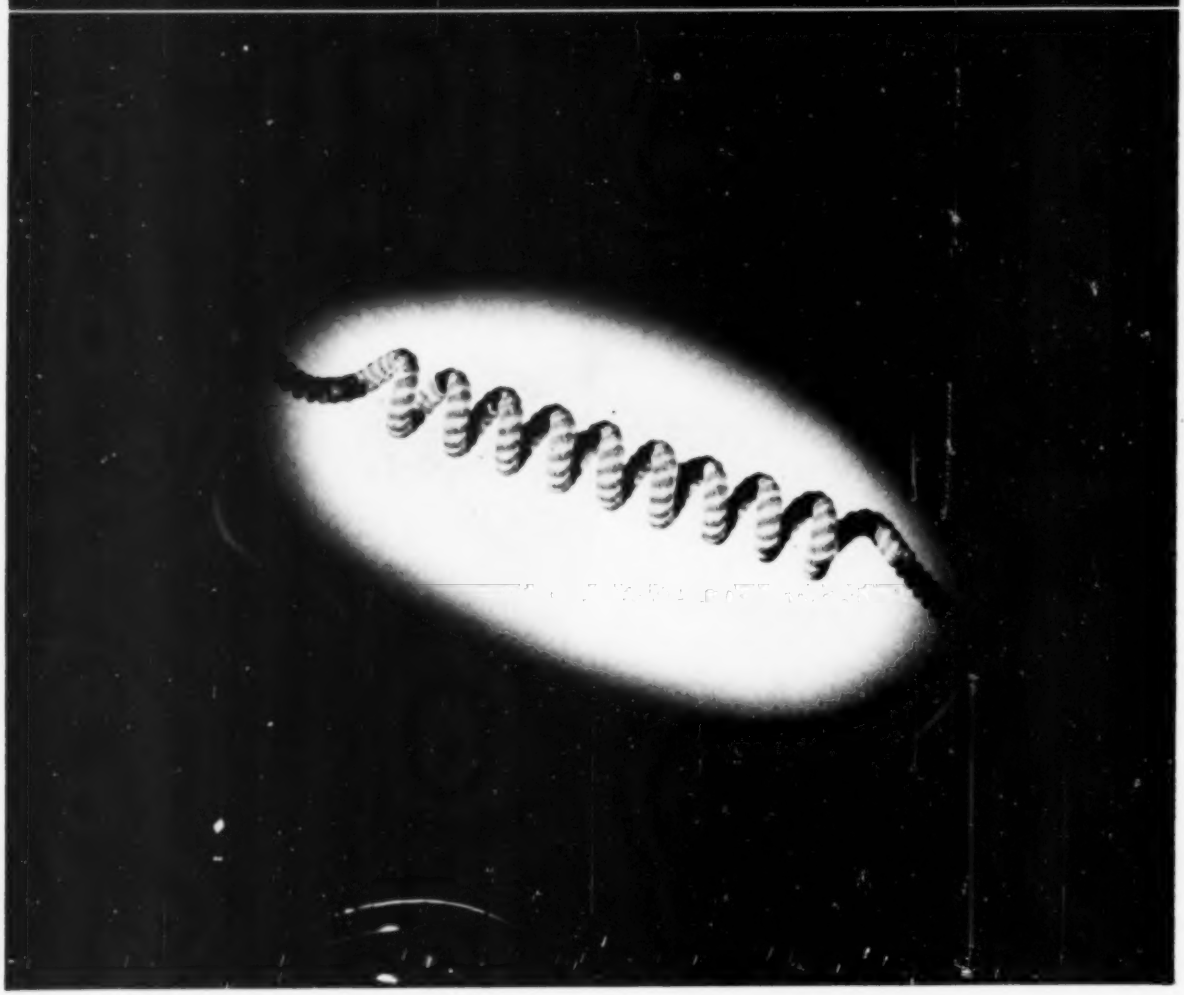

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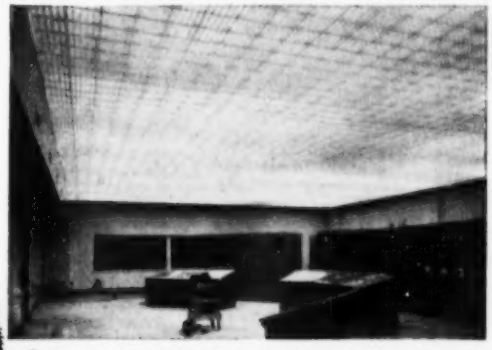

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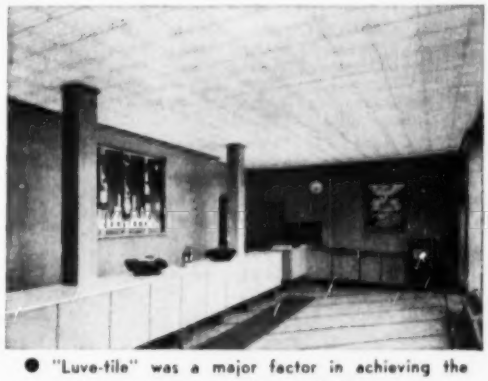

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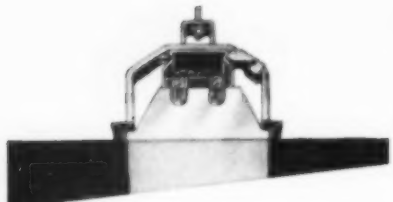

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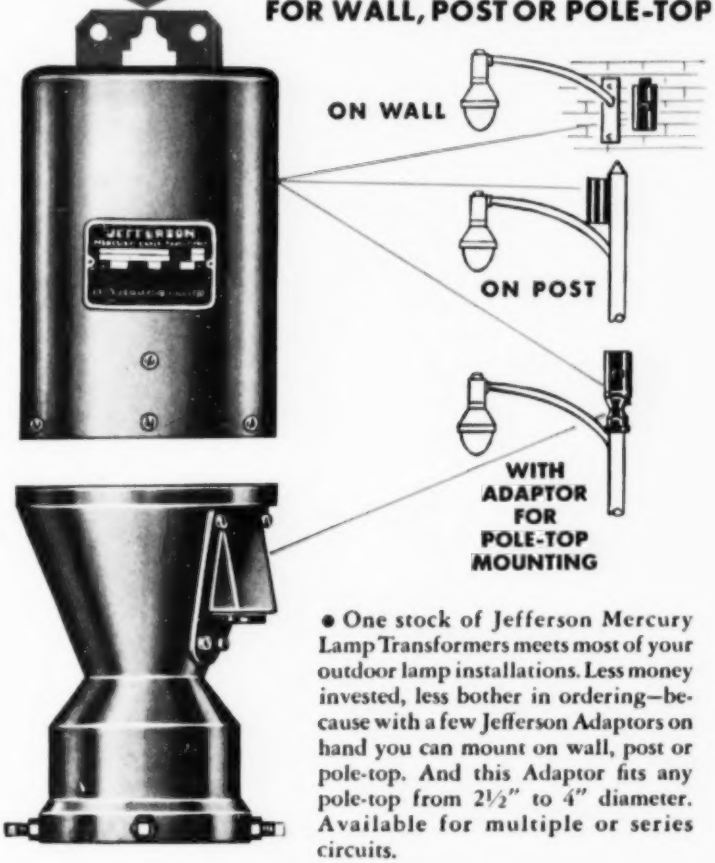

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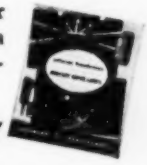

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INDEX TO ADVERTISERS
March 1953

Acme Electric Corp.	36A
Benjamin Electric Mfg. Co.	Back Cover
Day-Brite Lighting Inc.	4A
Garden City Plating & Mfg. Co.	14A
General Electric Co., Lamp	30A
Edwin F. Guth Co.	37A
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Miller Co.	34A
Philadelphia Elec. & Mfg. Co.	19A
Pittsburgh Reflector Co.	Inside Front Cover
Smithcraft Lighting Div.	27A
Sola Electric Co.	Inside Back Cover
Solux Corp.	38A
Sunbeam Lighting Co.	23A
Superior Electric Co.	24A
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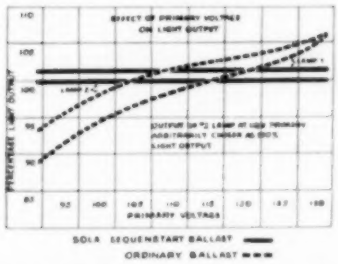

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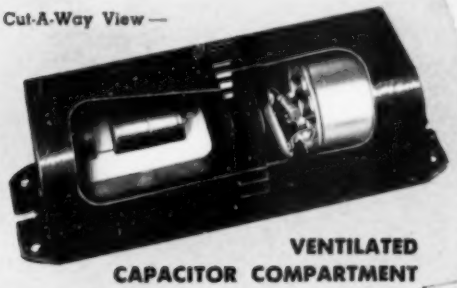

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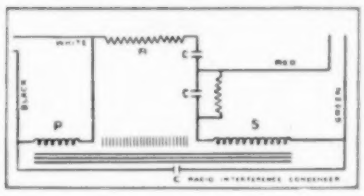

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SOLA *Fluorescent* BALLASTS

Designed in the tradition of Sola engineering leadership

Transformers for Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Luminous Tube Signs
SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois, Bishop 2-1414 • NEW YORK 35: 103 E. 125th St., THalgar 6-6464
PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988 • BOSTON: 246 Walnut St., Newtonville, Mass., DExter 2-2021
CLEVELAND 15: Swetland Bldg., PRospect 1-4005 • KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382 • Representatives in Principal Cities

NEW BENJAMIN "PANEL-GLO"
cuts former Benjamin Price for ceiling louvers by as much as 50%!

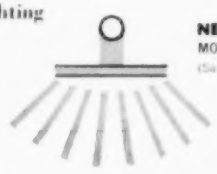
NEW BENJAMIN "SKY-GLO"
Louvers now priced approximately 33⅓% less!

2 Great Advancements Insure Quality Lighting to Benjamin's High Standards at New Lower Prices!

New low prices and all-around simplification of Benjamin luminous ceiling lighting enable you to increase your ceiling lighting prospects by offering a lower installed price. Benjamin "Sky-Glo" and "Panel-Glo" represent a brand-new approach to ceiling lighting for stores, offices, etc. Here is lighting that is engineered for simple, low-cost installation . . . designed for high-level, well-diffused lighting quality, featuring the maximum seeing comfort always associated with Benjamin *translucent* ceiling lighting.
Send for Free "Sky-Glo" and "Panel-Glo" Data Bulletin.
Benjamin Electric Mfg. Co., Dept. L, Des Plaines, Illinois.

NEW Simplicity brings down installed price!
New, practical, easy-to-handle 3' x 3' translucent panels or louver sections.

NEW, Easier Installation brings down installed price!
No need to order "fill-in" size panels. Trim them yourself with scissors . . . right on the job . . . to the exact shape desired!
New metal FINISHING STRIPS neatly hide trimmed edges on either louver or luminous-panel jobs.



NEW, proven TRANSLUCENT plastic material means MORE LIGHT with CONTROLLED BRIGHTNESS.
(Same material used for "Sky-Glo" and "Panel-Glo.")

NOW, figure the complete price of a ceiling-lighting job by the sq. ft.!
Sq. ft. price includes all panels or louver sections as well as all the channels, fittings, etc. you need to complete the installation!*
No calculating, no figuring . . . just know the area of the room!
No layouts necessary for regularly-shaped rooms.
*lighting equipment not included.

BENJAMIN
Lighting Equipment
sold exclusively through electrical distributors

B-173